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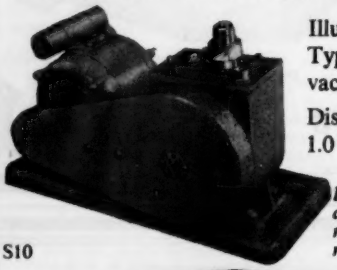

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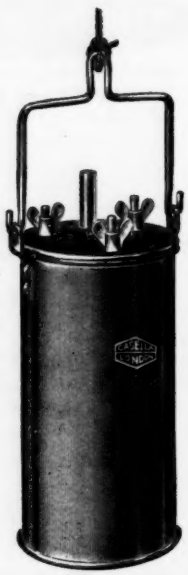

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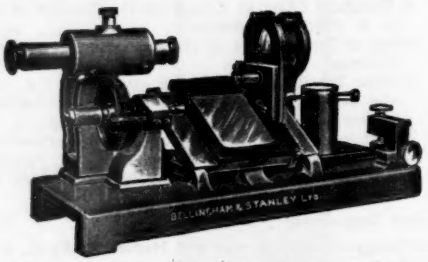

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THE NUCLEAR POWER PROGRAMME IN BRITAIN

THE statement regarding Britain's nuclear power programme which Lord Mills, the Minister of Power, and Mr. R. Maudling, the Paymaster-General, made in Parliament on March 5 had been expected for some time, even before the interruption in oil supplies through the closing of the Suez Canal last November made it desirable to decrease the country's dependence on oil. The success of the Calder Hall station had made it clear by the close of the year that nuclear power was likely to make a greater contribution to Britain's supply of energy within the next decade than was contemplated when the White Paper was issued in February 1955. Lord Citrine had indeed stated, at a ceremony inaugurating work on the nuclear power station being built at Bradwell in Essex, that the original programme is likely to be doubled, if not trebled, and had forecast the building of eighteen to twenty nuclear power stations before 1965 to supply the needs of the Central Electricity Authority. In announcing the coming into full operation of the second reactor at Calder Hall, Sir Christopher Hinton had forecast that the cost of power would fall below the 0·6*d.* a unit estimated in the White Paper—Sir John Cockcroft indicated a target of 0·4*d.* a unit at a conference at Harwell on November 30—and had given a most encouraging account of the first eight months experience at Calder Hall. British companies, he said, are already negotiating for the sale of nuclear power stations in Europe, and hope to sell one to Japan, while in the 1960's it would be necessary to build another chemical processing plant to handle the fuel used in the civil stations in Great Britain and abroad. The use of plutonium in thermal reactors, however, is less promising than was at first thought; but there is apparently considerable scope for fast reactors of the type now being constructed at Dounreay. Still more recently, in his Axel Johnson Lecture to the Royal Swedish Academy of Engineering Sciences at Stockholm on March 15, Sir Christopher forecast that the cost of electricity from nuclear power stations would fall in thirty years time to no more than 0·32*d.* a unit. Equally significant, he predicted that the increased thermal efficiencies and reduced capital costs of generators and boilers which have resulted from continuing improvements in the design of conventional power plants will be more than offset by the rise in the cost of coal. Sir Christopher suggested, accordingly, that the cost of power from conventional stations is likely to increase to 0·84*d.* a unit by 1990.

Lord Mills on February 5 said that Britain is already spending some £250 million per annum on importing fuel, chiefly oil, and this burden on the country's balance of payments will continue to grow. After reviewing the programme outlined in the White Paper of February 1955, in conjunction with the English and Scottish Electricity Authorities and the Atomic Energy Authority, he said that the Government has decided to aim at a nuclear capacity of 5,000–6,000 megawatts by the end of 1965 in place of the target of 1,500–2,000 megawatts of the White Paper, and the supply of raw materials for nuclear generation, the acquisition of sites and the planning of the transmission network will be on a scale sufficient to bring 6,000 megawatts of nuclear capacity into operation by the end of that year. The actual amount of nuclear capacity to be installed will be subject to technical experience and development as planning progresses, including the trend of capital costs, and to the availability of physical and financial resources. Lord Mills announced that the Electricity Board for Northern Ireland proposes to bring a 150-megawatt nuclear power station into commission in 1963 or 1964.

The execution of this programme, Lord Mills continued, will offer a saving of some 18 million tons of coal on a full operating year, but will involve also a large increase in the annual investment programme of the electricity authorities of Britain during the early 'sixties. Besides the very heavy burden on the nation's capital resources in a period when these resources are likely to be seriously strained, the programme will involve the erection of new power stations and of overhead transmission lines in parts of the country which have not hitherto felt the impact of the nation's requirements for power. This is inevitable, because nuclear power stations raise special siting problems; but the Government and the electricity authorities are determined to carry through the programme with the least possible interference with the amenities of the countryside or with the rights of individuals. They believe that this is possible; and at the same time they think there can be some acceleration of the present procedure to avoid the serious delays now occasioned; the Paymaster-General has indeed tabled amendments to existing legislation to that end for inclusion in the Electricity Bill now before Parliament.

In replying to the short discussion on this statement, in which the Government, as in the House of Commons, had been asked to submit a White Paper for debate in Parliament, Lord Mills explained that by material resources he meant not only sites but also steel and other materials, and he referred particularly to the scientists and engineers who would be engaged upon this work. The nuclear power programme, he said, in no way detracts from the importance of the coal industry. Coal is Britain's fundamental wealth, but the energy requirements of the country are growing rapidly and we need more coal, more oil and more nuclear energy, particularly if we are to press on with the mechanization of industry required to enable us to meet growing world competition. It is not the Government's present intention to issue a White Paper because the programme must remain flexible and subject to periodical review. With regard to cost, Lord Mills

estimates that the nuclear power stations will cost £1,460 million compared with £810 million for conventional power stations to give the same output; but certain additional costs will bring the difference to £750 million, though it is believed that cost will fall as the programme advances.

Lord Mills does not think it will be necessary to construct more than another sixteen nuclear stations in Britain in addition to those for which orders have already been placed. The programme has been phased in such a way that, at the time when we may expect the exports it is hoped to achieve will be growing, we shall be best able to expand them. The cost of generation at the three nuclear power stations which have been ordered is expected to be very slightly more than at new conventional stations, taking into account capital cost as well as operating cost; but it is confidently expected that the efficiency of nuclear power stations will improve much more rapidly than that of conventional stations, and that ultimately the cost of generating electricity at nuclear stations will be less than at conventional stations. Lord Mills agreed as to the importance of measuring this enormous capital cost against other capital needs, and he repeated the assurance he had previously given regarding the protection of amenities and the rights of individuals. While the Government is seeking to accelerate the procedure, he undertook to look fully into it to ensure that everything possible is done to protect the countryside and the rights of the individual.

Mr. Maudling gave similar replies to questions in the House of Commons, adding that he is sure the Minister will consider suggestions regarding a White Paper on the broader aspects of the fuel situation and that the Government is satisfied that technical resources will be available to execute the programme in full. So far as can be seen, in the present state of knowledge, all the stations in the programme will be of the Calder Hall type with considerable improvements and modifications; but there is no reason for departing from the estimate of cost given in the White Paper for 1955, and even with the new programme it will be necessary to increase imports of oil for several years to come. Mr. Maudling also said that the question of pump storage in relation to the base-load problem is much in the mind of the Government; but he gave no reply when asked whether the Minister will advance research in connexion with the use of hydroelectric power, and with the utilization of surplus nuclear power during the night, or to a further question on the supply of the necessary trained technologists and their adequate remuneration.

The trebling of the programme was warmly welcomed by Mr. A. Robens for the Opposition; although, in the House of Lords, Lord Lawson suggested it amounted to a new industrial revolution in which Parliament was not being consulted and that the National Parks Act was being torn up. Mr. Geoffrey Lloyd, also welcoming the statement, pointed out that it involves the expansion of certain key parts of the economy of Britain, such as the manufacture of nuclear graphite, the preparation of uranium and the fabrication of special steels, which will facilitate a further and earlier expansion of the programme. Lord Salisbury, in a brief intervention, indicated the willingness of the Government to arrange for a debate on the subject.

Replying to a subsequent question about capital investment on March 11, Mr. Maudling said that the total investment in nuclear power stations in Britain is expected to need rather more than £1,000 million by the end of 1965, of which a little more than £900 million represents the cost, including the initial fuel charge, of the stations due for completion by then. The £1,460 million given on March 5 appears to represent the combined investment in conventional and nuclear stations and transmission lines over the period 1961–65, and this revised figure of £900 million brings the total investment in electricity during the nine years 1956–65 to £2,900 million. Investment in hydroelectric power in Scotland is estimated to amount to £120 million by the end of 1965, and colliery development by the National Coal Board to some £850 million.

Mr. Maudling added on March 11 that the suggestion for a White Paper on the general fuel situation is still being considered; but he offered no estimate of the effect of the programme on the growth of oil imports or of the net cost of fuel imports. The Government can now be in little doubt that this long-delayed statement on the nuclear power programme was badly muddled in its presentation. In the House of Lords, Lord Alexander of Hillsborough, in welcoming the full replies to questions given by Lord Mills, frankly said that if the information had been given in the original statement, many of the questions would have been unnecessary. As it is, an impression is left that the Government does not fully apprehend the significance and implications of this great development, and more particularly its bearing on scientific and technical developments elsewhere or the demand that it makes for trained man-power. Questions to that end have been pressed in Parliament, and particularly in relation to the adequacy of steel supplies.

There are three particular respects which cause some anxiety. The careless presentation of this new programme quickens the concern which has long been expressed regarding the adequacy of Government organization for scientific research and development. The Lord President of the Council again failed to give any sign that he appreciates the misgivings with which the discrepancy between his immense responsibilities and the meagreness with which his office is staffed is viewed in responsible quarters. The failure to present the programme with an adequate explanation of its reasons and hopes once more suggests that the Lord President is too over-burdened with other duties, and the Government as a whole too indifferent to give the scientific and technological activities of Government the care and attention they need.

The second matter was the subject of a debate in the House of Lords on March 13. Lord Lawson again

raised the question of the siting of nuclear power stations and was obviously far from being satisfied or reassured by what Lord Mills had previously said on this subject. Lord Lawson maintained that both the National Parks Act and the Distribution of Industry Act are being side-tracked, and his concern was widely shared; nor did Lord Mills give a convincing answer in replying to the debate. He said that, for the present, because the nuclear power stations contain highly toxic materials and represent a new development which has not yet stood the test of operation on a large scale, the Government has decided they must be sited away from built-up areas; and Lord Mills could only repeat that the programme is flexible and that the Government will be guided by experience.

It would be unfair to suggest that Lord Mills is not concerned with the effects on amenity, or with the importance of public relations; though he did not respond to a plea for greater use of underground transmission in areas of natural beauty. He very clearly wishes to preserve the amenities of the countryside of Britain so far as possible, but to him the over-riding consideration is the need for power. What is lacking is the appreciation that there are some areas where amenity must come first if the preservation of the countryside is to have any meaning. The weakness in the presentation of this programme is the persistence of the piecemeal approach that has so often marred the handling of scientific and technical problems. Sir Josiah Eccles's address to the Parliamentary and Scientific Committee on March 12 at least indicated that the importance of public understanding and goodwill is appreciated, and that the threat to amenity may be less serious than appears.

If the doubts and misgivings which the programme has already aroused are to be removed, there must be no longer any suspicion that the Minister of Power, the Atomic Energy Authority, the electricity authorities and like bodies are allowed to be judges in their own cause. The claims of power must be weighed, and be seen to be weighed, along with those of other public interests and under conditions in which these other interests such as amenity may on occasion prevail. This is the point above all which matters in procedure—far more than the saving of time which Lord Mills himself stressed. Meanwhile, a clearer explanation of the Government's policy on siting and its reasons would help.

The third point to which this programme is related and on which concern is felt is its bearing on the export trade of Britain and our relations with, for example, Euratom. Mr. Maudling said in the House of Commons on March 13 that the Government favours co-operation in nuclear energy between the United Kingdom and Western Europe, including the countries which are forming Euratom, and that it has with other Western countries been working out practical measures in the Organization for European Economic Co-operation. Recently the United Kingdom Atomic Energy Authority held technical discussions with representatives of the Euratom countries on the part which gas-cooled reactors of the type ordered by electricity undertakings for installation in the United Kingdom might play in the Euratom nuclear power programme; and on March 1 the Authority offered in a joint communiqué to facilitate contacts between United Kingdom and European firms to assist in training scientists and engineers from the countries concerned. United Kingdom experts will continue their examination of the proposed Euratom power programme. Since Lord Mills spoke in the House of Lords on March 5, Mitchell Engineering, Ltd., of London, has announced that, with its American associate, it has received an order from Germany for a boiling-water reactor plant. Another British firm which has also formed a link with the United States is known to be making good headway already in foreign markets.

Mr. Maudling's statement indicates that the prospect of European orders for the British construction groups is opening; but when pressed in the House of Commons, Mr. Maudling declined to give any clearer indication of the Government's attitude to Euratom before it has been formed. Nevertheless, an imaginative British participation in Euratom from the start would do more than any guarantees to ensure that British industry and methods play an active part in the future industrial applications of nuclear energy which alone can keep the growing fuel imports of Euratom countries within bounds. A clear statement by the Government that it seeks a special and permanent relation with Euratom for Britain might well be to Britain's own advantage, at least as a unit in the Organization for European Economic Co-operation. The study of six specific types of reactor, two for commercial production before the end of 1965 and four for the decade 1965–75 included in the Atomic Energy Authority's development programme, may well run into difficult engineering problems as serious design studies begin, in which a joint programme of prototypes of power reactors might offer attractions. One deduction to be drawn from Sir John Cockcroft's address to the Parliamentary and Scientific Committee on March 12 could well be the value of technical co-operation to Britain.

Europe's chief interest is in Britain's scientific and technical knowledge, which have made Calder Hall and this revised programme possible; and Britain for her part has a clear interest in expanding this potential European market for reactors and power stations. Britain needs, too, a political guarantee that national discrimination will not expel British industry once its design and experience have been shared. Here, as in the expanded programme itself, the need is for vision as well as boldness, and the readiness to take calculated risks. But it is necessary to ask once again whether the organization for research and development in Britain is appropriate to the times, and whether in particular some further means is not required for ensuring that a wide view is taken in national as well as international problems, and that the piecemeal approach which is so wasteful and costly is decisively checked.

A NEW FORM FOR A GIANT RADIO TELESCOPE

By A. K. HEAD
Aeronautical Research Laboratories, Melbourne

THE usual type of general-purpose radio telescope is a steerable parabolic reflector. For operation at the important hydrogen line (1,420 Mc./s.) the parabola must not deviate from its theoretical shape by more than one inch, and with parabolas of 250-ft. diameter or larger under construction or consideration, the engineering design of a structure with sufficient stiffness to meet the allowable one-inch tolerance is a matter of great difficulty. It was therefore decided to investigate alternative focusing systems which might be easier to design and cheaper to construct.

It appeared that the main distortion of a parabolic reflector was the changing sag of the structure under its own dead weight as it moved through its range of orientations. The proposed system reduces this effect by using two reflectors: one a large fixed hemisphere and the other a small movable barrel-shaped reflector. An incoming signal (from a direction parallel to the axis of the barrel) is reflected by part of the hemisphere into the barrel, which reflects it into the final focus. To receive a signal from another direction it is only necessary to rotate the barrel about the centre of the hemisphere, another portion of which is then used.

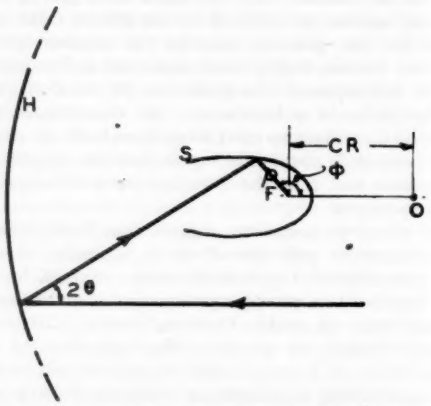

Fig. 1. Path of a typical ray through system. *F*, focus; *H*, hemispherical reflector; *O*, centre of hemisphere; *S*, second reflector

In Fig. 1 the path of a typical ray through the system is shown. From geometrical optics it can be shown that to produce a point focus from a parallel

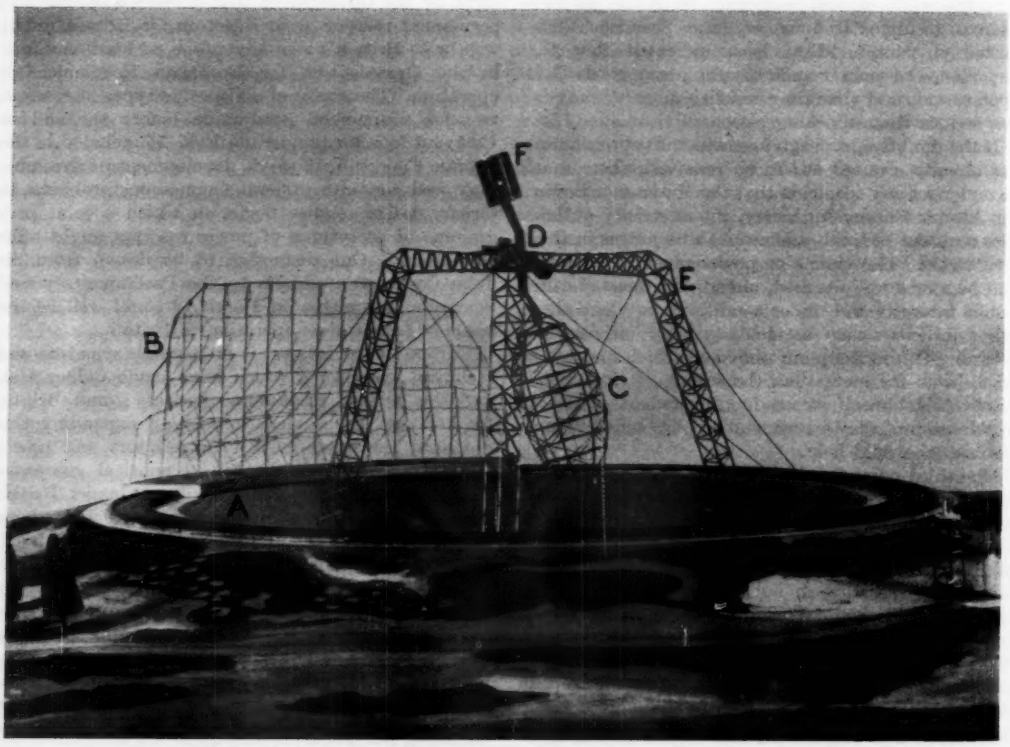

Fig. 2. Model of radio telescope. *A*, spherical reflector; *B*, movable extension of *A*; *C*, second reflector; *D*, equatorial bearings; *E* tripod; *F*, counter-weight

incident beam, the second mirror must have the shape given by the following parametric equations:

ρ,φ: polar co-ordinates of mirror about focus F

$$\varphi = 2\theta + 2 \arctan f(\theta)$$

$$\rho = \tfrac{1}{2}R\,(\sin\theta - C \sin 2\theta)\,[f(\theta) + 1/f(\theta)]$$

where $f(\theta) = (\sin\theta - C \sin 2\theta)/(K - 2\cos\theta + C\cos 2\theta)$, θ is a parameter, R is radius of hemisphere, CR is distance of focus from centre of hemisphere, and K is an adjustable constant.

Fig. 2 shows a model of a radio telescope designed on this principle to meet the following specification: diameter of beam, 250 ft.; angular coverage, 60° down from the zenith in any direction; operating wave-length, 21 cm. to 3 m.

The spherical reflector is of 250 ft. radius and is partly sunk into the ground. The model illustrates an alternative to building a complete hemisphere, in which only a section of the part of the hemisphere above ground is constructed, but this can be moved on a circular track as needed. This is possible, since only a circular area of the hemisphere of 250 ft. diameter is in use at any one time.

The second mirror rotates in equatorially mounted bearings which are mounted at the centre of the sphere by tripod legs. A counter-weight is provided to balance the second mirror, and the kinks in the shaft connecting counter-weight and mirror enable the telescope to be pointed at the pole without the shaft fouling the bearings.

Christiansen has considered the design of a suitable feed for this radio telescope. Preliminary results give a gain factor of 71 per cent with first side lobes of amplitude 13 per cent compared with the main lobe. Other side lobes are negligible, and it seems probable that the amplitude of the first side lobe can be reduced.

Pearcey has considered the effects of diffraction and has shown that, for wave-lengths longer than 3 metres, diffraction in the mouth of the second mirror may modify the performance as calculated by geometrical optics. However, McGee has shown that at wave-lengths of 3 metres or longer the spherical reflector is a sufficiently close approximation to a parabola for operation with a 250-ft. diameter beam. Thus a suitable feed placed at the paraxial focus of the sphere (which is at the mouth of the second mirror) extends the operating range of the telescope to longer wave-lengths.

Comparing this system with the equivalent parabola, it appears that the gain and side lobes are similar, and that both can operate over the same range of wave-lengths. Apart from the probable advantage in cost (particularly if an existing hole in the ground can be used) this system also provides good shielding of the focus from interference, and an equatorial mount can be easily provided. A disadvantage is that, in correcting spherical aberration, the second mirror introduces coma, so that operation with a displaced feed is impracticable. Full details of this work will be submitted to the *Australian Journal of Physics*.

I would like to thank L. H. Mitchell of the Aeronautical Research Laboratories, J. L. Pawsey, W. N. Christiansen, T. Pearcey and R. X. McGee of the Division of Radiophysics, Commonwealth Scientific and Industrial Research Organization, for their advice and for making available their unpublished work referred to above, and the Chief Scientist, Department of Supply, for permission to publish this account.

AN AUSTRALOPITHECINE OBJECT FROM MAKAPANSGAT

By Prof. RAYMOND A. DART
University of the Witwatersrand

EVER since the Taungs discovery in 1925 I have maintained that the cavern breccias, in which the australopithecine remains were discovered, were the midden-heaps of these creatures. The accumulated evidence for australopithecine use of bones, teeth and horns as tools was recently summarized in the Smithsonian Report for 1955 in an article entitled "Cultural Status of the South African Man-Apes".

The failure to discover unequivocal evidence of stone tools in australopithecine deposits caused me to search particularly in 1948 for the explanation of double-depressional or double-valleculated cranial fractures found in the skulls of baboons and in australopithecine brain casts. This sharply localized type of cranial fracture was found at Taungs, Sterkfontein and Makapansgat, sites spread over a territory with a diameter of about 400 miles. The cranial depressions were found to correspond closely with the double-ridged epicondyles of the distal ends of ungulate humeri. As these ungulate arm bones with broken epicondylar ridges occurred with great frequency in some australopithecine deposits (they have hitherto been found to be the most frequently occurring of all long bones in the Makapansgat deposit) I had no hesitation in attributing these cranial fractures to impacts from such objects, and thus to these protohuman creatures a bone-bludgeon hunting technique.

The systematic collection of every bone fragment isolated from the Makapansgat breccia during the decade 1945–55 enabled me finally to present the results of a statistical analysis of 7,159 fragments at the Third Pan-African Congress in Prehistory held at Livingstone in July 1955. Statistics then showed that the most frequently occurring type of fragment in this *Australopithecus prometheus* deposit, outnumbering even arm-bones (or humeri), were lower jaws (or mandibles), the miraculous weapon of Samson and of various mythological heroes, such as the Polynesian sun-god Maui and Perdix (or Tales, or Calos), the nephew of Dædalus.

A predatory transition from ape to man was originally envisaged by Darwin in "The Descent of Man" and is now corroborated by this remarkable grey bone breccia of Makapansgat. The detailed evidence afforded by the aforementioned 7,159 fragments need not delay us here. It has been detailed in the tenth memoir of the Transvaal Museum, Pretoria (1957), dealing with "The Osteodontokeratic Culture of *Australopithecus prometheus*".

Attention has been directed in that memoir to some particularly curious specimens: a very small antelope mandible wedged in an antelope atlas; four examples of antelope bones or parts of bones lying inside other broken long bones or retained by the lime in their broken ends; and an antelope calcaneus wedged between the zygomatic arch and side wall of a hyæna skull. The statement was also made there that "Accustomed employers of pointed horns, ulnæ and the broken shafts of antelopes' long bones as penetrating implements would scarcely fail to exhibit in respect of hollow bones and elongated slivers of bone—such as, whether by accident or design, encompassed them in their cavern environment—the degree of intelligent behaviour normally exhibited by chimpanzees, when they ardently desire objects at a distance or in crevices".

On my way back to South Africa from the International Congress in Anthropological and Ethnological Sciences in Philadelphia (September 1956), which I had been privileged to attend by the generosity of the Wilkie Foundation in order to speak about the osteodontokeratic culture, I had an opportunity of seeing the attractive australopithecine display at the British Museum (Natural History). There to my astonishment and pleasure among the bone fragments from Makapansgat I beheld the most striking example of this very phenomenon of crevice-exploration or depth-sounding by these creatures that I have hitherto encountered.

The bone fragments in the British Museum display came from pieces of the grey australopithecine breccia from Makapansgat chosen in 1950 by Dr. L. H. Wells (now professor of anatomy in the University of Cape Town) and sent to Dr. Kenneth Oakley as typical samples of the breccia for submission to whatever tests might prove desirable and for subsequent development in London. The particular specimen that riveted my attention is illustrated in Fig. 1, a drawing by Miss Camilla Wybrants from a cast courteously prepared for me from the original by Dr. Oakley after my visit. The femur of a large antelope recently derived from another block of the same breccia was used for indicating the outline of the missing portion of the bone.

The central feature of the specimen is the right horn-core of an extinct type of antelope (*Gazella gracilior*, Wells and Cooke, *Palaeontologia africana* 1957), a form very similar to the living red-fronted gazelle of North Africa, and having horn-cores 5–6 in. in length. Dr. H. B. S. Cooke informs me that this particular horn-core happens to be one of the largest of its type that he has seen hitherto.

The peculiarity about the horn-core is that, apparently after isolation from the remainder of the skull, it had been rammed like a plunger or thrust like a dagger down to the hilt—formed by the orbital fragment of skull still attached thereto—through the broken end of the distal, or lower half of the cavity in the previously shattered femur of one of the largest antelope types (such as an oryx) found represented in the deposit. Apparently the horn-core had been forced down so vigorously and had become so tightly impacted therein that it either was not, or could not be, extracted afterwards. At any rate, the horn-core now lies there fixed within the femur by calcite so firmly that the preparator could not separate them without fracturing the encircling femur.

Fortunately or otherwise, the horn-core and the surrounding lime and femur have also been broken through by the blasting activities of the miners in

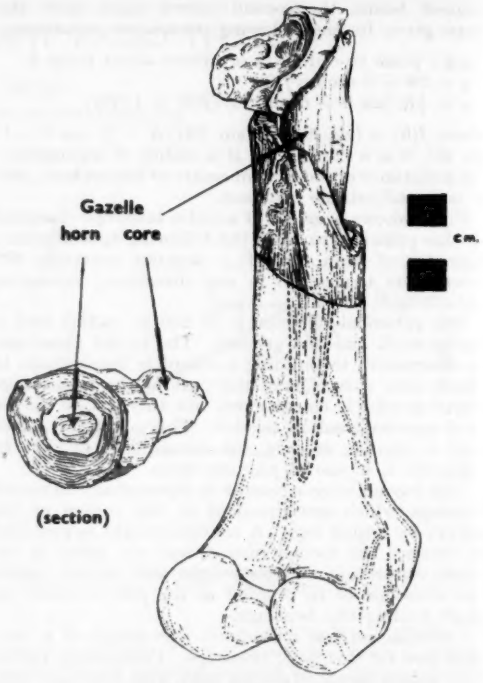

Fig. 1. Drawings in section and profile of a cast of the fossilized extinct gazelle horn-core from the Makapansgat Limeworks grey breccia which is on display in the australopithecine exhibit at the British Museum (Natural History) and which was found impacted within the upper end of a previously-broken large antelope's thigh bone (femur)
For the sake of clarity, ghost-like reconstructional outlines of the distal portions of the femur and horn-core, that are missing from the exhibited specimen owing to its having been shattered during the mining operations, have been added by the artist, Miss Camilla Wybrants, to the profile drawing of the fragments from information supplied by other corresponding fragments from the same breccia

such a way as to expose them in section (see Fig. 1) obliquely 2–2½ in. away from the attachment of the horn-core to the skull. A sufficient length of the femur, however, is present to identify the bone and approximately also the large type of antelope to which it originally belonged.

Some observers, including even the late Dr. Robert Broom, as well as Oakley, Von Koenigswald and others, have repeatedly raised the time-honoured[1] but now discredited[2] query about Carnivora, especially hyænas, being responsible for australopithecine and other human deposits. The value of this particular specimen lies in its furnishing solidified in stone a tolerably convincing (and, for Londoners, easily accessible) example of the type of phenomenon exhibited repeatedly by the Makapansgat grey breccia, that cannot be attributed to hyæna (or to any other carnivore), or to a porcupine (or to any other rodent), or to any other supposed bone-accumulator lacking the manipulative skill and explorative curiosity characteristic of man. The associated employment of a long bone and a horn essential for the accomplishment of the feat embodied in this specimen, on the other hand, is reminiscent of the ability, spontaneously exhibited by some chimpanzees, to insert a rod-like object into a tubular one for the purpose of increasing its length

and so bringing a desirable object, otherwise inaccessible, within reach.

Since the Makapansgat grey breccia has furnished various other illustrations of this cavity-exploring ability on the part of these predatory employers of bone bludgeons and horn-core daggers, a specimen like this makes it highly probable that these protohuman creatures had also made the conceptual leap chimpanzees can make of putting two things together to extend their reach; and thus, of improving the penetrating power of elongated objects such as sticks and so turning them into spears by capping their ends with hollow horns. The recent discovery of Kafuan stone artefacts and australopithecine remains in the pink breccia overlying the grey breccia at Makapansgat has also been the subject of report (see *Nature*, **175**, 16; 1955, and **176**, 170; 1955); they therefore possessed the means of shaping the ends of sticks.

[1] Buckland, Rev. W., *Phil. Trans. Roy. Soc.*, **112**, 171 (1822). Zapfe, H., *Palaeonbiologica*, **7**, 111 (1938).

[2] Hughes, Ainn E., *S. Afr. J. Sci.*, **51**, 156 (1954); *Amer. J. Phys. Anthrop.*, **12**, n.s.4, 467 (1954). Dart, Raymond A., *Amer. Anthrop.*, **58**, 40 (1956).

INFLUENCE OF LIGHT ON PLANT GROWTH

A JOINT symposium on the influence of light on plant growth arranged by the Association of Applied Biologists and the Horticultural Education Association was held in the British Museum (Natural History) on February 22. The morning session was devoted to a discussion of certain aspects of photoperiodism in plants. The photoperiodic control of flowering in short-day plants was reviewed by Dr. D. Vince (University of Reading), with special reference to the chrysanthemum. In short-day plants, providing that they have first been exposed to light of high intensity, flowering is determined by exposure to dark periods of more than a certain critical length. During the dark period reactions occur that promote flowering, which may be inhibited or reduced by light of low intensity, by the application of auxin to the leaves, and by low temperatures. Red light (6550 A.) is most effective in suppressing flowering in several species (including chrysanthemum) when given in the middle of an inductive dark period; the effect of red light can be annulled by later exposure to infra-red radiation (7350 A.). Many other light-sensitive growth phenomena have been shown to exhibit this type of response to successive exposure to red light and infra-red radiation. Subjecting the chrysanthemum to low temperatures during an inductive dark period may markedly reduce its effect. Initiation of inflorescence primordia may be retarded indefinitely, and in some varieties a marked terminal, vegetative rosette forms. If initiation occurs, the plant may behave as if it were in long-day conditions, that is to say, bracts and capitulum are formed but floret initiation is suppressed. If floret initiation occurs, the number of disk florets is reduced as in long-day conditions. Low temperature during a preceding long-day period may also affect the response to inductive photoperiods; in some varieties break bud formation occurs at favourable temperatures in short days following exposure to low temperature in long days.

Photoperiod regulates numerous other phenomena in plants, including dormancy in woody species. Dr. P. F. Wareing (University of Manchester) showed that in many species the onset of dormancy occurs in response to short photoperiods, the stimulus being perceived (as in the flowering response) by the leaves. The resumption of growth normally requires exposure to low temperatures, but is photoperiodically controlled in some species; leafless seedlings of beech will grow out in long photoperiods and, in this instance, the stimulus is perceived by the buds. Some species, including birch, show an interaction between chilling and day length; unchilled seedlings will only resume growth in long photoperiods, but chilled seedlings elongate in any day length. Sensitivity to photoperiod is also exhibited by seeds of birch. At 15° C. the percentage of seeds germinating is increased in long days; this is a true photoperiodic response, being controlled primarily by the length of the dark period. The interaction of temperature with photoperiod was again stressed since at 20° C. germination occurs in response to a single exposure to light. Birch seeds thus show the typical red/infra-red response of light-sensitive seeds at high temperatures and a photoperiodic response at lower temperatures. After chilling, the seeds are no longer light-sensitive. Experiments carried out to elucidate the mechanism of light-sensitivity suggest the presence of an inhibitor in the seed coat, which undergoes destructive oxidation since, whereas the excised embryo shows no photoperiodic response and has a low oxygen requirement, the percentage of whole seeds germinating in the dark is increased by leaching, by slitting the seed, and by increasing the oxygen concentration (slit or scratched seeds only).

Mr. I. H. Williams (University of Nottingham) demonstrated the importance of photoperiod as a factor controlling growth and development in the raspberry 'Malling Promise'. Under natural conditions, the biennial cane grows vegetatively in the first summer; as the days shorten in the autumn, the cane becomes dormant and flower primordia are initiated in the axillary buds. In the second summer these mixed fruiting laterals grow out and a replacement shoot arises at the base of the two-year old cane. Initiation of flower primordia occurs during falling temperatures and shortening days and experiments in growth rooms have demonstrated the marked interaction between temperature and day length; at 10° C. initiation occurs in all day lengths, but at higher temperatures primordia are initiated only in short days. The lateral shoots remain dormant in subsequent long days unless chilled at 3·5° C. for six weeks; the resumption of growth in this species is not, therefore, photoperiodically controlled. The process of breaking dormancy can be separated from that of flower initiation by exposing the plants to 3·5° C. in the dark without previous exposure to short days or cool temperatures, when vegetative laterals will grow out in subsequent conditions of long days and high temperatures. Mr. Williams directed attention to the effect of the physiological age of the shoot on its response; following exposure to inductive conditions (short days at 10° C.) for

eight weeks, shoots of 12 nodes remained vegetative and continued growth on the main axis only; 15-node plants developed flowers after six to eight weeks, 20-node plants after three weeks, and 30-node plants after one week of such treatment.

The observed interactions between temperature and photoperiodic behaviour link the three papers. In chrysanthemum inductive photoperiods may be ineffective at, or when preceded by, low temperatures; dormant seedlings of birch are no longer sensitive to photoperiod after chilling; birch seeds are light-sensitive at 20° C., photoperiodically sensitive at 15° C., and will germinate in the dark after exposure to low temperature; raspberry canes are photoperiodic at 15·5° C. but will initiate flower primordia in any day length at 10° C. The various types of interaction are of considerable interest, and their mechanism merits further study.

The afternoon session was opened by a paper by Dr. van der Veen (Philips Research Laboratories, Eindhoven, Holland) on the influence of coloured light. Dr. van der Veen emphasized the technical difficulties of obtaining light of high spectral purity at intensities sufficiently great to maintain growth, and demonstrated that a very small amount of contamination at certain wave-lengths may be important. Blue light with a small amount of near infra-red may cause internode elongation, whereas pure blue light results in internode shortening; a small amount of infra-red in red light is less important because of the red/infra-red antagonism in many species. Dr. van der Veen emphasized the complexity of the reaction of plants to coloured light, pointing out that response may vary according to the species and to the method of application. The effectiveness of a flash of red light in the middle of a long dark period in promoting flowering in long-day plants and inhibiting flowering in short-day plants is well established. However, the long-day plant *Hyocyamus niger* will not flower in long days in red light alone, but will flower in the same day length when a small amount of near infra-red radiation is added. Variations between species was illustrated by reference to leaf expansion, which is promoted in many species by red light but occurs only in blue light in *Mirabilis*, and to internode extension, which may be increased (tomato) or decreased (pea) by exposure to red light.

Practical plant irradiation was the subject of the final paper by Mr. A. E. Canham (Electrical Research Association), who discussed the relative merits of several standard types of lamp for various applications in horticulture. Lamps may be used in insulated dark structures to replace daylight or in glasshouses, as a supplement to natural daylight when the light intensity is low; different factors must be taken into consideration in the two methods of irradiation. When daylight is replaced entirely, both formative and photosynthetic effects must be considered; the maximum rate of photosynthesis occurs in red light but the formative response to wave-length varies widely with species and, with the present limitation of knowledge, radiation in all visible wave-lengths, with no undue preponderance in one band and with little near infra-red radiation, is recommended. 'Daylight' fluorescent lamps have been found to be most satisfactory in producing 'normal' growth but, because of their low intrinsic brightness, large numbers are required. The formative effects of lamps are less important for supplementary irradiation since daylight will tend to balance the lamp effect, but an unduly high proportion of red or near infra-red may result in elongation and/or leaf epinasty in some species. Providing the formative effect is not unfavourable, economic and practical considerations largely determine the choice of lamp; of the lamp types currently available the high-pressure mercury vapour lamp is generally recommended.

The symposium concluded with a film by Mr. A. G. Sparkes (West End Nurseries, Angmering) showing the use of photoperiodic regulation in practice to achieve flowering of chrysanthemums all the year round. With suitable schedules of lighting, and shading with black cloth, flowers may be cut in every week of the year.

The papers presented at the symposium will be published in *Scientific Horticulture*. D. Vince

A FLORA OF EUROPE

By Prof. N. A. Burges and Dr V. H. Heywood
University of Liverpool

Historically, plant taxonomy has tended to pass through phases of local exploration, consolidation and regional synthesis, occasionally the whole cycle being repeated at a higher level of knowledge. In Europe, however, taxonomy has never attained this overall regional view. On the other hand, no other continent or part of the world, with a flora comparable in number of species, displays such a diversity of partial Floras, each with independent criteria and more or less strict adherence to national or local boundaries.

With the exception of some areas in Spain and the Balkans, few basic systematic novelties await discovery and description in Europe. Individually, most European countries can now claim that the descriptive-geographical taxonomy of their flora has been satisfactorily achieved. With the new tools of cytogenetics, ecology and biometrics and like disciplines, and with the new ideas inspired by modern genetical and evolutionary theory, much of the work now undertaken by European taxonomists on their own floras is of an experimental or evolutionary nature. Descriptive taxonomy is largely limited to that of the colonies or other territories administered by their parent countries.

There are signs that this local analysis, in the absence of compensating synthesis, may prove detrimental to taxonomy as a whole. The position is such that to answer almost any question on European taxonomy the specialist has to refer to upwards of fifty Floras and countless papers and then synthesize the resultant information. This is time-consuming enough for the professional taxonomist who knows the literature well and who has it available (and

there must be few indeed who would claim this distinction to-day); but for the workers in other fields such as evolution, phytogeography, etc., who are dependent on easily accessible taxonomic data the position is almost intolerable. Only the large national herbaria can afford to stock the necessary literature, and the number of taxonomists with adequate training and experience of European taxonomy as a whole is, rightly or wrongly, so small as to constitute a distinct problem.

Although some works have a wider scope—for example, Hegi's monumental "Illustrierte Flora von Mittel-Europa" and more recently Hylander's "Nordisk Kärlväxtflora", covering Fennoscandia, Iceland and the Faeroes—there is still no overall treatment of Europe.

In an attempt to alleviate this situation, a committee has been formed of British and Irish botanists to consider the possibilities of writing a Flora of Europe, condensing in three or four volumes the essence of the scattered published information about European plant taxonomy. Much progress has been made, and it now seems likely that the proposed Flora has every chance of success. A number of distinguished European colleagues have declared their support and interest in the project and some of them have consented to act as advisory editors. The Linnean Society of London has promised its patronage and the Director of the Royal Botanic Gardens, Kew, and the Keeper of Botany at the British Museum (Natural History) have agreed to assist in an advisory capacity.

The Flora will cover Europe in the normally accepted sense of the word and will connect up with the area covered by Komarov's "Flora of the URSS". The intention is to key and describe briefly all the major taxa of Angiosperms and Gymnosperms that grow spontaneously in Europe. Subspecies will be included, but not as a rule varieties unless they are well marked or have some claim to consideration at a higher taxonomic level. Those taxa which are currently given a binomial in widely used Floras but which clearly do not deserve full specific rank will not be reduced in status in the Flora unless there is strong evidence for such action; normal procedure will be to include them in their original binomial form after the species to which they appear to be most closely related.

The Editorial Committee is: Prof. T. G. Tutin (University of Leicester, *chairman*), Dr. V. H. Heywood (University of Liverpool, *secretary*), Prof. N. A. Burges (University of Liverpool), Prof. D. H. Valentine (University of Durham), Dr. S. M. Walters (University of Cambridge) and Prof. D. A. Webb (University of Dublin, Trinity College).

Further information about the progress of the Flora will be published from time to time in the journal *Taxon*.

OBITUARY

Sir John Simonsen, F.R.S.

With the sudden death on February 20 of Sir John Lionel Simonsen passed one of the last of the chemists trained in the Edwardian experimental tradition. He was born in 1884, his father being a naturalized Danish merchant and his mother also originally Danish; John Lionel remained in intimate contact with his Danish relations all his life. He was educated at Manchester Grammar School and then obtained first-class honours under W. H. Perkin, jun., at the Victoria University, Manchester, his contemporaries there including Sir Robert Robinson, Sir Norman Haworth and C. S. Gibson.

His career included both academic and public service, and fell into four main chapters. First, six years research at Manchester, as research fellow and later assistant lecturer. Secondly, seventeen years in India—1910–19, professor of chemistry, Presidency College, Madras; 1919–25, Forest Research Institute and College, Dehra Dun; 1925–27, professor of organic chemistry, Indian Institute of Science, Bangalore. Then, from 1930 until 1942, he was professor of chemistry at the University College of North Wales, Bangor; and finally, until the end of 1952, director of Colonial Products Research, South Kensington, London.

In the laboratory Simonsen's sure technique was a joy to watch; typically his bench carried a few covered conical flasks or beakers, a few stoppered test-tubes, all labelled, and perhaps a distillation in progress; the rest would be an empty expanse of gleaming teak. His 176 published experimental papers—a large output since so many antedated micro-analysis—cover the whole period 1910–42, and much was done with his own rapid, skilful hands. Nearly all this work was on terpene chemistry, that on barbaloin being a notable exception; it included a long series on Indian trees and grasses, and later many papers on Australian oils supplied by A. R. Penfold (these papers always carried also Penfold's name). He was soon an acknowledged authority in the field, and his book "The Terpenes", published in two volumes in 1930–32, became at once the standard work. This edition stopped at the bicyclic series, but the second edition, which covers also the higher terpenes, runs to five volumes and has been written in collaboration with L. N. Owen, D. H. R. Barton and C. W. J. Ross; he lived to pass the proofs of the last volume, and to the end collected references from the Chemical Society library for a third edition.

Simonsen's public services rank alongside his scientific work. It was he and Dr. MacMahon who, by personal letters, started the Indian Science Congress in 1914, with two hundred members; he was its honorary secretary from that beginning until 1926, and its president in 1928; the present membership of thousands is testimony to his foresight. For three years during the First World War he was controller of oils and chemical adviser to the Indian Munitions Board. It was mainly due to him and Sir Robert Robinson that the Microbiological Research Institute was founded in 1944 in Trinidad, as part of his enthusiasm for the development of Colonial resources.

Simonsen received the Kaiser-i-Hind Silver Medal in 1921, and a knighthood in 1949. He was elected a Fellow of the Royal Society in 1932, received its Davy Medal in 1950, was the first recipient of the

Fritzsche Award of the American Chemical Society (1949), and his honorary degrees were D.Sc. of Birmingham and of Malaya, and LL.D. of St. Andrews. He served as honorary secretary of the Chemical Society (1945–49), of which he was later elected a vice-president; he was on the Council of the Royal Society of Arts, was honorary treasurer of the Laws Agricultural Trust, Rothamsted, and was on many committees.

His public and academic honours pleased but did not corrupt him, any more than did the material temptations of his Indian years: he remained an essentially simple, lovable man, behind a rather formal manner. Simonsen was, however, no slack master; the writer, when interviewed for a junior post, felt obliged to say that he would have quickly to seek a better-paid one: Simonsen replied, "Of course; if that were not so, you would not work and then you would be of no use to me". His teaching ability is shown by the fact that one honours class, at Bangor, of five students included two who were later to become professors of chemistry (E. R. H. Jones and W. C. Evans). Simonsen's opinions were always clear-cut and he did not hide them. Honesty, organic chemistry, verification before publication, credit where it was due, internationalism in science, but loyalty to one's country and one's friends were good: priority-hunting, sloppy experimentation, meanness, laziness, and the enemies of one's friends were bad. Though the Edwardian certainty is now out of fashion, Simonsen's ideals shine by contrast the brighter. But most memorable was his kindness; that was one reward he gave for service, not only immediately but also long after the service ceased; his advice and scientific help, however, were open to all; and many a young scientist, unknown to him previously, acknowledges in print the trouble Simonsen would take in seeking Colonial materials for him. It was only typical that the residue of his estate is destined, after the death of his widow, for the Royal Society's Scientific Relief Fund.

He married, in 1913, Dr. Jannet Dick Hendrie, of Nairn, then in charge of the Lady Dufferin Hospital, Madras. Her charity of mind and very personal grace and charm made for him an ideal home in which he was happy and active to the end. R. S. Cahn

John Simonsen was my oldest friend in academic circles and his passing breaks almost the last link with the palmy days when Perkin was at the height of his powers at the University of Manchester. He was one year senior to me, but we were close companions in the Schunck and Perkin (as now called) Laboratories for several years and even collaborated in a new attack on barbaloin. He was a most elegant experimentalist and the outcome of the work was a revision of the structures of aloemodin and rhein, the latter being recognized for the first time as a dihydroxyanthraquinonecarboxylic acid. In those early years he developed a most unusual talent for handling alicyclic substances and this led him into his brilliant excursions in the field of the higher terpene chemistry.

In later years and in company with Alexander King, we journeyed together to the Caribbean and initiated a successful antimalarial campaign in British Guiana and also a Microbiological Institute in Trinidad.

He was a most lovable person, incapable of any mean action, transparently sincere in all his relations, personal and scientific. It was a great privilege to enjoy his steadfast friendship for half a century, and I certainly owe more to him than I can well express, more probably than I realize. A modest man, easily under-estimated, he nevertheless was very firm in defence of his high standards and principles. I make no attempt to discuss the important discoveries he made, such as the carenes, or his public services, too numerous to mention. I only wish to pay a tribute to the memory of a warm-hearted, fair-minded and beloved friend. R. Robinson

NEWS and VIEWS

Atoms for Peace Award: Prof. Niels Bohr, For.Mem.R.S.

Prof. Niels Bohr, professor of theoretical physics at the University of Copenhagen, is to be the first recipient of the Atoms for Peace Award. He was unanimously selected from among seventy-five nominees representing twenty-three nations by the trustees of the Atoms for Peace Awards, meeting at the Massachusetts Institute for Technology on March 6. Atoms for Peace Awards, Inc., is a non-profit-making corporation set up, in response to President Eisenhower's appeal at the Geneva conference in July 1955, as a memorial to Henry and Edsel Ford. The Award, which consists of a gold medal together with an honorarium of 75,000 dollars, is to be granted annually—without regard for nationality or politics—for outstanding contributions to the peaceful uses of atomic energy.

Born in 1885 in Copenhagen, Dr. Bohr came to England in 1912 to work with Rutherford at the University of Manchester on theories of atomic radiation. In 1913 he began to publish a series of papers, in which he enunciated the model of the quantized atom with which his name is always associated. For his work on atomic structure and radiation theory he was awarded the Nobel Prize in physics in 1922. In 1916, Prof. Bohr was appointed to the chair of theoretical physics at the University of Copenhagen. On his initiative the Institute for Theoretical Physics was opened there: he has since been its director.

In 1936 Prof. Bohr turned to nuclear physics and proposed a theory of nuclear reaction which successfully interpreted the experiments of Enrico Fermi and others on the interaction of neutrons with nuclei. During a visit to the United States in 1939, Prof. Bohr, in collaboration with Dr. J. A. Wheeler, contributed to the understanding of the nuclear fission observations of Otto Hahn and Lise Meitner by identifying the fissile isotope as uranium-235. Prof. Bohr returned to his Institute in Denmark in 1940. In October 1943 he was forced to flee his country, which had become occupied. He escaped to Sweden, hidden in a fishing boat, and from there he was flown in the bomb-bay of a Mosquito bomber to England. He went to the United States in December of that year to take part in the war-time atomic energy development. After the War, Prof. Bohr returned to

Copenhagen. In 1952 the Institute was selected as the temporary location for the theoretical group of CERN, the European organization for nuclear research. This joint effort of twelve nations had an early advocate in Prof. Bohr, who held that responsibility for applying advances in atomic science to peaceful rather than warlike uses rests upon all peoples of all nations. CERN'S activity continued under Prof. Bohr's direction until 1954 and was housed at the Institute until 1956. In 1955 the Danish Government established an Atomic Energy Commission to study the utilization of atomic energy for scientific and industrial purposes and appointed Prof. Bohr as its chairman.

Meldola Medal Award : Dr. T. S. West

DR. T. S. WEST, of the University of Birmingham, has been awarded the Meldola Medal for 1956. The Meldola Medal, which is the gift of the Society of Maccabaeans, is awarded each year to the British chemist less than thirty years of age who is considered to have shown the greatest promise as indicated by his or her published work. Awards are made by the Council of the Royal Institute of Chemistry, with the concurrence of the Society of Maccabaeans.

Dr. West is a graduate of the University of Aberdeen, where his interest in analytical chemistry was aroused by his association with Dr. R. Belcher. When he moved to the University of Birmingham, where he received the Ph.D. degree in analytical chemistry in 1952, this association was continued. Dr. West was appointed lecturer in the University of Birmingham in 1955. The earlier phases of his research were concerned with the development of new reagents for titrimetric analysis. In the course of this work, mercurous nitrate was developed as a stable new titrant and was shown to have widespread applications to chemical analysis. An extensive study was made of the quantitative reactions of water, which led to the formulation of a considerably more reactive alternative to the Karl Fischer reagent for moisture determination. Further work was carried out on the analytical applications of co-ordination compounds of the trivalent manganese ion and particularly on the chelating action of ethylenediaminetetraacetic acid on unusual valency states of metal ions. In 1952, Dr. West was awarded a senior Department of Scientific and Industrial Research Fellowship and, in conjunction with Dr. Belcher, initiated a programme for the development of a comprehensive scheme of ultimate organic ultramicroanalysis on the 50 μgm.-sample scale. For this purpose a simple robust quartz-fibre ultra-microbalance of the torsion-restoration type was constructed. New projects have included the study of O,O′-dihydroxyazo dyestuffs as *p*M (metal ion) indicators, the synthesis of iminodiacetic acid substituted dyes as reagents for inorganic analysis and the evolution of a new range of powerful chelating agents.

The Marlow Medal : Dr. J. S. Rowlinson

DR. J. S. ROWLINSON, of the Chemistry Department, University of Manchester, has been awarded the first Marlow Medal and Prize by the Faraday Society for his researches on the thermodynamics and statistical mechanics of gas, liquids and mixtures. The presentation of the Medal will be made at the annual general meeting of the Society to be held at Oxford in September. The award, which comprises the Medal and a grant of not more than fifty pounds, is made annually and is based on publications (not necessarily in the *Transactions of the Faraday Society*) over the preceding three years on any subject normally published in the *Transactions*. It is restricted to members of the Faraday Society of not less than three years standing and not exceeding thirty-three years of age.

Honorary Fellowship of the Imperial College

THE following have been elected to honorary fellowships of the Imperial College of Science and Technology : Sir Harold Bishop, director of technical services at the B.B.C. ; Dr. E. Hindle, formerly scientific director of the Zoological Society of London and regius professor of zoology in the University of Glasgow ; Prof. H. Levy, professor emeritus of mathematics at the Imperial College ; Mr. P. Rabone, a leading authority in the field of mineral dressing ; Prof. H. H. Read, professor emeritus and senior research fellow in geology at the Imperial College and a former pro-rector ; Dr. A. P. Rowe, vice-chancellor of the University of Adelaide ; Mr. C. E. R. Sams, former secretary and past-president of the Old Centralians (association of past students of the City and Guilds College).

National Research Council of Canada : Dr. R. F. Farquharson, M.B.E.

DR. R. F. FARQUHARSON, head of the Department of Medicine, University of Toronto, has been appointed vice-president (scientific) of the National Research Council of Canada, with responsibilities for medicine. The appointment is a part-time one and Dr. Farquharson will continue in his present post at the University of Toronto. While the Council has no medical laboratories of its own, its Division of Medical Research makes grants in support of basic medical research at hospitals and universities. For the past ten years the Council's medical programme has been directed by Dr. J. B. Collip, dean of medicine in the University of Western Ontario, and, under his direction, this part of the National Research Council's work has been built up to the point where a vice-president with medical responsibilities is desirable. Dr. Collip is to retire as director of the Division of Medical Research in the autumn, when Dr. Farquharson will assume direction of this Division.

Staff College for Technical Teachers

IN a recent address to the Association of Technical Institutions, Mr. D. R. O. Thomas, chief education officer of the United Steel Companies, recommended the establishment of a staff college for teachers doing advanced work in technical colleges. The main purposes of the college would be to enable teachers of advanced technology to consolidate and widen their knowledge and to improve their skill in teaching, to give them opportunities of identifying and discussing their own problems and of exchanging ideas and experience and to help to maintain the status and prestige of the teaching profession in technical colleges, in comparison with university teaching and with industrial occupations. A residential centre should be established of such a size that it could be run economically on a basis of continuous operation. An outstanding person with wide experience in staff college methods would be required to initiate the programme, direct the studies and set the tone and standard of work in the college. The programme of courses and conferences should cover all aspects of technology.

The purpose would be to give priority to lecturers and teachers who have a number of years of service ahead of them, and to relate teaching methods to the dynamic nature of advanced industrial techniques. The college should be able to provide opportunities for intensive short courses and conferences on the teaching of any aspect of technology at the more advanced levels.

Radioactive Substances in Technical Colleges

Technical colleges are expected to play their part in developing the use by industry of radioactive substances, X-rays and gamma-rays. Courses of instruction or research in these fields, however, call for special precautions on the part of the colleges to protect students and staff involved. In a recent memorandum to local education authorities, the Minister of Education advises the appointment of technically competent safety officers to be specifically responsible for advice on radiological protection in colleges where radioactive materials are used. The memorandum advises the use of separate laboratories, reserved solely for radioactive work; the provision of secure and adequately shielded storage places for radioactive substances, and the installation of mechanical ventilation where there is risk of radioactive gases. Other suggestions refer to the necessity of controlling removal of materials from storage, their transport from place to place and the disposal of radioactive wastes by methods which must be agreed with local authorities. Decontamination of equipment and clothing is also extremely important. Special precautions should be taken in the use of X-ray apparatus; and installations which are not completely protected should be placed in a separate room which should be unoccupied during exposure. The Minister refers particularly to the danger of exposure to gamma-rays. Because of the amount of protection required it may often be impossible to provide indoor accommodation in which operation can safely be carried out, and it may therefore be necessary to conduct gamma-radiography in the open air in a roped-off area. Colleges are asked to inform the Ministry before starting instruction or research in this field.

The Palæontological Association

On January 30, at a meeting attended by about seventy palæontologists and those interested in palæontology, it was resolved to form a Palæontological Association. An inaugural meeting was held on February 27 at the Imperial College of Science and Technology, at which a constitution was adopted and the following elected as council and officers for 1957: *President*, Dr. R. G. S. Hudson; *Vice-Presidents*, Dr. E. I. White and Mr. N. F. Hughes; *Treasurer*, Dr. W. S. McKerrow, Department of Geology, University Museum, Oxford; *Editor*, Dr. W. H. C. Ramsbottom; *Secretary*, Dr. F. Hodson, Department of Geology, University of Reading; *Other Members of Council*, Dr. F. W. Anderson, Dr. T. Barnard, Prof. O. M. B. Bulman, Dr. F. E. Eames, Mr. G. F. Elliott, Prof. T. N. George, Dr. Dorothy H. Rayner, Mr. P. C. Sylvester-Bradley, Dr. J. T. Temple, Dr. Gwyn Thomas, Prof. T. S. Westoll, Prof. W. T. Whittard, Prof. Alwyn Williams and Prof. A. Wood. The Association, which seeks support from all who are interested in palæontology, plans to hold discussion-meetings in London and other centres in Britain. It is intended that the Association's activities shall cover all aspects and branches of the subject. A journal is being planned. Membership can be obtained by paying an annual subscription of two guineas.

Science in France

Under the title "Scientific Information", the French Ministry for Foreign Affairs (Department of Cultural Relations) is issuing for free distribution to scientific organizations on request a bulletin summarizing recent scientific activities in France. The first issue (Informations Scientifique, No. 1, 1956. Pp. 52. Paris: Ministère des Affaires Étrangères) outlines the formation and organization of the National Centre for Scientific Research, the scope of scientific and technical research on potash in Alsace and the organization of the Society for Chemical Studies for Industry and Agriculture, which has a research centre at Argenteuil, and the new centre for biological and pharmaceutical research at Strasbourg. Some recent researches in French laboratories on nuclear physics and atomic energy, on poliomyelitis, on the synthesis of granite, etc., are briefly described. Following a section noting features in higher education in France and in the work of the Academy of Sciences, there is a useful annotated bibliography of French scientific works published in 1955.

The Art of Lecturing

In a short booklet Dr. G. Kitson Clark, of the University of Cambridge, points out that while the Army, civil defence authorities, various religious denominations, political parties and many other organizations provide training for their lecturers, it is not normal for a university to do so; the assumption is made that dons should be able to lecture by the light of Nature. To help those who are willing to learn, Clark sets out some valuable pointers drawn from his own experience on such topics as the content of subject-matter, the length of lectures, the stance and posture of the lecturer, the use of microphones and of the blackboard, voice production, the use of notes by the lecturer and the making of them by his audience. The booklet has been published by W. Heffer and Sons, Cambridge, price 1*s.* 6*d.*

Klamath Prehistory

The Klamath area in Oregon adjoins the Great Basin, but differs from it in possessing a constant water supply, of which the effect on the life of the inhabitants is clearly shown in a report recently published (*Trans. Amer. Phil. Soc.*, New Series, 46, Part 4: Klamath Prehistory—The Prehistory of the Culture of the Klamath Lake Area, Oregon. By L. S. Cressman, William G. Haag, and William S. Laughlin. Pp. ii+375–514. Philadelphia: American Philosophical Society, 1956. 2 dollars). In historic times the area was occupied by the Klamath Indians. In the course of four seasons work, Dr. Cressman accumulated the data which are the subject of the report. By excavation of house pits, going back from quite recent times to at least A.D. 1500, an earlier midden and a cave, he has traced a continuous occupation back to before a volcanic eruption which took place about 5500 B.C. Despite minor variations, the inhabitants of this region never progressed beyond a food-gathering and fishing economy. This is an interesting and well-illustrated account. The area it deals with is small and rather specialized, but the way in which the archæology is described and related to neighbouring areas gives it more than a local import-

ance. It is a very useful contribution to the archæology of a large part of the western United States.

Hints for Plant Collectors

A USEFUL little handbook, "Instructions for Collectors" (No. 10, British Museum (Natural History); sixth edition, 1957; price 2*s*.), with a preface by Dr. George Taylor, tells the plant collector what he should know if he is to set about the job in the right way: when, where and what to collect, how to collect, label and annotate, pack and transport. It is all here, in some seventy-two pages, with helpful notes on the proper handling of the abundant and diverse materials of the plant kingdom, from algae to xerophytes, mention being made of several new techniques which are not yet widely known but which should contribute much towards preserving plants in good condition for future study and reference.

A Cæsium Clock

IN the issue of *Atoms for Peace Digest* for February 23 (2, No. 19), the fortnightly periodical of the United States Information Service, brief details are given of the 'Atomichron', the first cæsium atom-beam clock to be available commercially in the United States, and probably in the world. It has been designed by the National Company, Inc., of Malden, Massachusetts, and developed under the guidance of Prof. J. R. Zacharias, of the Massachusetts Institute of Technology. The model costs 50,000 dollars, weighs 500 lb. and measures 84 in. × 22 in. × 18 in. It is capable of keeping time to an accuracy of five seconds over a period of 300 years, and is based on the 9 192 631 830 Mc./s. frequency of the cæsium atom. The Atomichron has already been used by the U.S. Armed Forces in navigation systems. It should find application in the improvement of astronomical observations, long-range navigation, radio communications, surveying and map-making, and in the study of basic physics, particularly the accurate determination of the velocity of light.

Kodaikanal Observatory

THE annual report of the Kodaikanal Observatory for 1955 (Delhi: Manager of Publications, 1956) deals chiefly with the astronomical and allied geophysical work of the Observatory. The meteorological and seismological data and the administrative details are published elsewhere. An expedition of seven members from the Observatory set up a camp at Hingurakgoda, Ceylon, to observe the total eclipse of June 20, 1955; unfortunately optical observations were impossible owing to cloudy weather, but geomagnetic, ionospheric and radio-astronomical observations were successfully made. During the partial eclipse of December 14, 1955, geomagnetic and ionospheric observations were made at Kodaikanal and a close watch was kept on the variations of solar activity on that day. The report contains an account of scientific co-operation between the Observatory and other institutions, including exchanges of spectroheliograms with foreign observatories, quarterly statements relating to solar flares, which were sent to the Royal Greenwich Observatory and Meudon Observatory, periodical lists of solar flares sent to a number of scientific workers in India and abroad, information relating to the central meridian passage of sunspot groups and forecasts of expected magnetic and ionospheric disturbances, supplied to certain interested institutions in India. Other matters dealt with include sunspot activity, solar flares, prominences, radio astronomy, geomagnetic observations, ionospheric observations, cosmic rays, seismology, meteorology, library research and publications.

Kodaikanal Observatory Bulletin, No. 141, Part 1 (pp. 373–416. Delhi: Manager of Publications, 1956. Rs. 4/8/0), embodies the results of observations of prominences made at the Observatory during the second half of 1953, supplemented by data from Mt. Wilson and Meudon, which have provided spectroheliograms for those days on which Kodaikanal had imperfect or no photographs. Magnetic observations for the same period are also included.

Polish Scientific Publications

THE Polish Cultural Institute (81 Portland Place, London, W.1) issues a selective "Quarterly Guide to Polish Periodical Literature". The entries are classified alphabetically under subject headings and in the first issue of Vol. 2 (January 1957) those relating to scientific subjects (under biology, biochemistry, chemistry, electrotechnics, geodesy and cartography, geography and geology, mathematics, mechanics, civil engineering, philosophy, physics, physiology, and history of science) occupy some twenty pages out of the fifty-seven. The titles of articles are given in English, and there is a list of periodicals covered.

Ninth Pacific Science Congress

THE ninth Pacific Science Congress of the Pacific Science Association will be held in Bangkok during November 18–December 9, 1957, under the auspices of the Government of Thailand and the Science Society of Thailand. A number of symposia are being arranged, for which papers are invited, on subjects including geology and geophysics, meteorology, oceanography, fisheries, zoology, entomology, botany, conservation, soil and land classification, forest resources, crop and animal improvement, development of natural resources, anthropology and social sciences, public health and medical science, nutrition and museums. Details may be obtained from the Secretariat, Pacific Science Association, Bishop Museum, Honolulu 17, Hawaii. The Royal Society would be interested to know of British scientists intending to be present at the Congress.

International Congress of Pure and Applied Chemistry

THE sixteenth International Congress of Pure and Applied Chemistry is to be held in Paris during July 18–24. The Congress is to be in three divisions: that on physical chemistry will discuss physico-chemical aspects of radioactive elements, combustion of gaseous mixtures, water in chemical compounds and diffusion in liquids and gels. The inorganic chemistry division will discuss solid compounds of the transition metals, the combinations of boron with hydrogen and non-metallic elements, the chemical properties of the actinium series and of substances at high temperatures. The organic chemistry division will deal with reaction mechanisms and intramolecular rearrangements, organo-metallic and organo-metalloidic compounds, selective reactions and orientation phenomena, stereochemistry, and the structure and synthesis of natural compounds. Applications for membership of the Congress and abstracts of papers from British authors should be sent to the British National Committee for Chemistry, Burlington House, Piccadilly, W.1, as soon as possible.

Announcements

Dr. Denis Taylor, head of the Electronics and Instrument Division at the Atomic Energy Research Establishment, Harwell, has been appointed a director and general manager of Plessey Nucleonics, Ltd. In addition he will become research executive of the Aircraft and Electronics Groups of the Plessey Co., Ltd., and will be responsible for the co-ordination of the company's nuclear programme.

Prof. J. W. Howie, Gardiner professor of bacteriology in the University of Glasgow, and formerly head of the Department of Pathology and Bacteriology, Rowett Research Institute, Aberdeen, has been appointed a member of the Agricultural Research Council in succession to Prof. J. S. Young, who has resigned.

The following appointments in the University of Leeds are announced: Dr. G. B. Cook, as lecturer in electronic computing; and Dr. D. Kirby, as lecturer in mathematics.

The following appointments in the University of Exeter, to take effect from October 1, have been announced: Prof. H. N. Rydon, professor of chemistry and director of the Applied Chemistry Laboratories, College of Science and Technology, Manchester, to the chair of chemistry in succession to Prof. H. T. S. Britton; Prof. D. J. O'Connor, professor of philosophy, University of Liverpool, to the chair of philosophy in succession to Prof. I. Levine.

In a written answer given in the House of Commons on March 28, Sir Edward Boyle, Parliamentary Secretary to the Ministry of Education, estimated the number of State Scholarship holders (including technical State scholarships awarded to mature students and awards made in supplementation of open university scholarships) who entered on degree courses in pure science and technology in 1956–57 as 809 and 383, respectively, compared with 772 and 353 in 1955–56 and 746 and 351 in 1954–55. For mathematics and medicine the corresponding figures are: 296 and 207; 273 and 243; and 270 and 258.

The second edition of "Methods of Chemical Analysis as applied to Sewage and Sewage Effluents" has been published by H.M. Stationery Office, 1956, price 10*s*. net. It is a well-bound book of 96 pages and contains clear descriptions of methods and reagents, with thirty-nine references to original publications.

The offer of supplies of *d,l*-aldosterone by the Endocrinology Study Section of the National Institutes of Health, Maryland, from material made available by CIBA Pharmaceutical Products, Inc., was mentioned in *Nature* of March 16, p. 567. We are informed that small quantities can also be obtained in Great Britain from CIBA Laboratories, Horsham, Sussex.

The British Iron and Steel Research Association will hold two open days at the Sketty Hall, Swansea laboratories, during June 19–21, for representatives of member firms and users of steel sheet and strip throughout industry. The Sketty Hall laboratories are devoted to research into problems concerning steel coatings and methods of surface preparation conducted by the Association's Mechanical Working Division.

The eleventh International Management Congress of the International Committee for Scientific Management will be held in Paris during June 24–28. The administration of the Congress will be in the hands of the Comité National de l'Organisation Française. Lieut.-Colonel L. F. Urwick will deliver an address on "Taylor: His Life and Work" to commemorate the centenary of the birth of Frederick Winslow Taylor, 'the father' of scientific management, on June 27. Further details can be obtained from the British Institute of Management, 8 Hill Street, London, W.1.

A symposium on "Molecular Structure and Spectroscopy" will be held at the Department of Physics and Astronomy, the Ohio State University, during June 10–14. There will be discussions on the interpretation of molecular spectroscopic data as well as on methods for obtaining such data. In addition, there will be sessions devoted to phases of spectroscopy of current interest. Further information can be obtained from Prof. H. H. Nielsen, Department of Physics and Astronomy, Ohio State University, Columbus 10, Ohio.

The twenty-second Cold Spring Harbor Symposium on Quantitative Biology will be held during June 3–12. The topic of the meetings will be "Population Studies: Animal Ecology and Demography". Individual sessions will deal with the historical aspects of human populations, demographic analysis of human populations, studies of experimental populations, ecological aspects of natural populations, the structure of communities, and the population as a unit of evolution. The Symposium is open to all who are interested, but because of space limitations it is important to make advance reservations. Further information can be obtained from the Director, Biological Laboratory, Cold Spring Harbor, New York.

The Ergonomics Research Society is arranging a symposium on "The Changing Demands of Modern Work and Control", to be held at the University of Bristol during April 8–11. The symposium will, as far as possible, be organized into homogeneous sessions, each consisting of a number of short papers by specialists, followed by open discussion. The object is to bring together specialists and research workers in industry, engineering, science and medicine. The proceedings should be of interest to those watching the emerging pattern of the nation's work and prosperity as it changes with modern methods of automatic control. Further details can be obtained from the honorary secretary, Dr. O. G. Edholm, Department of Human Physiology, Medical Research Council Laboratories, Holly Hill, Hampstead, London, N.W.3.

The International School of Physics of the Italian Physical Society is to hold a Summer School devoted to "Solid State Physics" at Varenna on Lake Como in the Villa Monastero during July 14–August 3. The course, which is organized under the auspices of the Italian Ministry of Education, the Italian National Research Council, the Italian National Committee of Nuclear Research and the University of Milan, will include lectures in English or French on the quantum theory of solids, point imperfections in solids, dislocations, metal physics and semiconductors. The School will be conducted by eminent specialists from the United Kingdom, the United States and Europe, under the direction of Prof. Fausto Fumi, professor of theoretical physics at the University of Palermo, to whom all inquiries should be addressed. Applications must be submitted before May 31.

ATTITUDES TO WORK

A TEAM from the Medical Research Council has carried out an investigation in three large mass-production factories in England to determine the attitudes of the workers to two important aspects of their working life: the operation which they performed at the bench or the conveyor belt, and the system by which they were paid. Its report describes the methods of investigation and the main findings*.

The method used was the direct one of personal interview, each man being invited to answer the interviewer's questions as fully and frankly as he could, and to indicate the strength of his views on each topic by reference to a five-point scale.

The general attitude to the five forms of group payment studied was predominantly favourable, though some forms were more satisfying than others. On the whole, communal bonus and group piecework systems were the most satisfying and group unit and indirect bonus systems the least.

The form of payment was by no means the only determinant of attitude. Other influential factors were: (*a*) the size and composition of the working group; (*b*) the type of work; (*c*) comparisons with other systems of payment; (*d*) the way a system was administered by the firm; it was impossible to say that one form of payment was intrinsically better or worse than another.

Some of the skilled men in the higher wage groups thought they were underpaid in relation to unskilled workers, and some of the men in the lower wage groups thought that wages were good for the type of work they did. There was, however, a direct relation between attitude to the payment system and actual earnings when the same form of payment yielded different levels of earnings in comparable groups.

Satisfaction with group payment was more marked among men in the higher than in the lower age groups. The older men, as compared with the younger, appreciated the comfort, co-operation and friendly feeling associated with group payment.

The attitude to group payment was more favourable in small than in large groups. Men in small groups (less than ten) as compared with men in large groups (more than fifty) spoke more frequently of the favourable effects of group payment on earnings and personal relations, and less frequently of its levelling and restrictive effects. They also had much less to say about slackers.

The reasons for liking and disliking the five forms of group payment were many and varied. According to the classification used in this survey, the largest group of distinguishable comments centred around the effects of group payment on earnings, and this was followed by comments on social aspects and incentive values. There were also many comparisons with other systems of payment.

Comments on the effects of group payment on earnings included references to standard times, rates of payment, the amount and consistency of the weekly wage or bonus, and the levelling effects on earnings. Comments were favourable when standard times and rates of payment yielded a good and consistent wage or bonus; they were unfavourable when earnings were adversely affected by anomalies in rates and standards and by material and mechanical difficulties. The results as a whole suggest that good wages, like good rates and standards, tended to be taken for granted, but any downward deviation from the accepted level was usually resented and sometimes strongly condemned.

Some men liked group payment because they all received the same wage, and some disliked it for the same reason. It was also liked by men in the larger groups because it smoothed out the effects of good and bad jobs.

The number of comments on the social aspects of group payment varied with the form of payment; in some they equalled or closely approached the number of comments on monetary aspects and in others they were almost negligible.

Most of the favourable comments referred to the satisfaction derived from working together as a team, and most of the unfavourable comments to slackers. There was some evidence that adverse comments on slackers and slow workers were relatively more numerous when groups were large and the wage incentive was strong; they tended to be less frequent when the rate of working was controlled by the speed of a moving belt. A fairly large proportion of men liked a group payment system because it encouraged them to work. The proportion was highest when groups were small, compact and homogeneous and when the bonus rate increased as the level of efficiency increased. Conversely, a number of men said that group payment was discouraging, because earnings were not related to individual effort and output; this attitude was particularly noticeable in the group of men on indirect bonus. There was also some evidence that the stronger the wage incentive the greater was the resentment towards anything that obstructed it.

The proportion of men who said they were unable to check their earnings ranged from 41·7 per cent to 81·2 per cent in the five factory groups, but the number who gave this as a reason for disliking the payment system was comparatively small. Inability to calculate earnings increased with the complexity of the system, the size of the working group and, presumably, with the inadequacy of the information and explanation given to the workers.

About 40 per cent of the men compared their own system of payment with other systems. Most of the comparisons were with individual piece-rates and there were almost as many favourable as unfavourable comparisons. The attitude to one form of payment (communal bonus) was also influenced by comparisons with an earlier system (group unit).

The opinions of the workers were, on the whole, endorsed by the supervisors, though the latter tended to comment more frequently on the social and administrative aspects of group payment and less frequently on its relation to earnings.

Almost all the supervisors said that the main and often the only incentive to work was the weekly wage, and many of them thought that the workers would be more satisfied with an individual form of payment by results.

* Medical Research Council. Special Report Series, No. 292: A Study of Attitudes to Factory Work. By S. Wyatt and R. Marriott, assisted by R. A. Denerley, H. Campbell, J. Walker, Yvonne Kapp, and F. G. L. Stock. Pp. vii+115. (London: H.M. Stationery Office, 1956.) 10*s.* net.

Despite the tentative nature of most of the findings, it is fairly safe to say that group incentive payment schemes are likely to yield the best results when: (*a*) groups are small, compact and stable; (*b*) the members of a group are well matched and engaged on the same type of work; (*c*) the form of payment is simple and the workers are able to translate output into earnings as work proceeds throughout the week; (*d*) there are no anomalies in rates and standards within a group or between groups; (*e*) output depends on the worker rather than on the machine; (*f*) the operational cycle is fairly short and repetitive; (*g*) variations in the quality and flow of material are reduced to a minimum; (*h*) the group is able to earn a reasonable bonus. (It is generally recognized that the bonus should be about one-third of the time rate, but the optimum rate has never been determined); (*i*) there is an atmosphere of mutual trust and understanding between management and workers.

When the operations in a department are too varied and irregular for sectional payment the incentive scheme may have to be related to departmental output. This is fairly straightforward when the product is uniform, but it is not easy when there are several products and the proportions vary from week to week. Under such conditions it is necessary to determine the number of man-hours per unit of output for each type of product and convert them to a common basis. The same procedure can, of course, be applied to factory output, though the scheme will lose some of its incentive value as its remoteness from individual effort increases. On the other hand, a payment scheme based on the total output of a department or factory is less costly in administrative and clerical work than one based on the output of individuals or small groups. It also reduces or eliminates many sources of friction and facilitates the movement or interchange of workers.

SCIENCE AND THE LONDON COUNTY COUNCIL

FEW London citizens are aware of the considerable amount of work done on their behalf by the Scientific Branch of the Public Health Department of the London County Council. Yet this branch, under the scientific adviser, Dr. S. G. Burgess, has a staff of fifty-nine which includes twenty-six graduates. The function of the branch is to advise all departments of the Council on scientific matters. The work of the branch is carried out in three groups of laboratories, the headquarters laboratories at the County Hall and those at the Northern and Southern Outfall Works situated at Beckton and Crossness. A recent report* of the scientific adviser describes the work carried out in 1955. During the year, 30,335 samples were taken in connexion with renewed investigations into sewage treatments, paints and surface coatings, building materials, school meals, drinking water, swimming baths, ventilation of vehicular tunnels, lubricating oils, polishes, disinfectants, insecticides and fungicides and other topics.

New work was commenced on air pollution, regular observations being taken at twenty sites. The observations made showed a marked difference between rural and urban conditions, and also variation in different localities within the County due to local sources of pollution. Seasonal fluctuations were clearly marked at all sites, the generally higher level of pollution in winter being due to the combined effect of increased coal consumption and the occurrence of meteorological conditions unfavourable to the dispersion of chimney gases. When the results are examined over a period of years they show a slight reduction in the amounts of tarry matter and smoke; this can be accounted for by the replacement of many domestic fires by the more efficient combustion units of blocks of flats. A distinction could be drawn between the effects of domestic and industrial combustion. For example, on week-days the smoke to sulphur ratio is at a minimum during the night, when most domestic fires die down, while some industry keeps running. At week-ends, when a greater proportion of industry is closed down, and domestic fires are burning for longer periods, this ratio is found to be higher than for comparable periods during the week.

A new series of investigations has been made into the effects of discharging trade effluents into sewers. 940 samples were taken, and of these 193, or 20·4 per cent, were considered to contravene the appropriate Act. Of this number, 86 were discharges with varying degrees of acidity. The acids identified included hydrochloric from pickling shops, nitric acid from photo-engravers, sulphuric acid from plating and anodizing shops, acetic acid from pickle manufacturers, citric acid from soft drink manufacturers and formic acid used for descaling and cleaning cookers. Also found were mixed organic acids similar to acetic acid from distilleries, bakeries and other works using fermentation processes. Wastes containing suspended matter in sufficient quantity to cause deposition and partial blockage of the sewers were those containing fats, thick mineral oils, tar, paint residues, vegetable fibres and tannery wastes.

In two cases, complete blockage of pipe sewers had taken place. One of these was caused by the wet grinding of stone and the other by a mixture of siliceous material and caustic metasilicate from a vitreous enamelling works. Of wastes containing inflammable solvents, the larger number were from garages, consisting of mixtures of waste lubricating oil with varying quantities of paraffin and petroleum spirit. One sample contained 37 per cent by volume of petroleum spirit. Three wastes from paint works contained white spirit or solvent naphtha. Another waste consisting of wash and cooling water, from a biological products plant, contained traces of monochlorbenzene and was sufficiently hot and of such total volume that the solvent, vaporized in the sewer, rendered the atmosphere unbreathable. Waste heat contained in process and cooling waters was another source of nuisance and possible dangers in the sewers. About forty cases of discharges above the 110° F. temperature limit laid down in the Act were investigated during the year. The adviser recommends that manufacturers should consider ways and means of recovering such waste heat in the interests of efficiency and economy.

In many cases following the examination of samples which contravene the Act, officers of the Scientific Branch and of the Chief Engineer's Department visit the premises to bring to the notice of the occupiers the particular nature of the offence and to discuss the problems involved in treating the discharges.

* London County Council: Public Health Department, Scientific Branch. Annual Report of the Scientific Adviser for the year 1955. Pp. 28. (London: London County Council, 1956.) 1*s*.

REFRACTIVE ERRORS OF THE HUMAN EYE

A COMPARATIVELY short Medical Research Council Report* on "Emmetropia and its Aberrations" contains a wealth of stimulating ideas and original data on the causes and incidence of refractive errors in the human adult eye. It will engage the attention of ophthalmologists, refractionists, physiologists and human geneticists. While a knowledge of elementary biological statistics is required to understand the full implications of the results, the authors have taken great care to state their conclusions clearly in plain language and also graphically.

The report opens with an excellent, comprehensive and critical review of previous studies in this field. The main part of the report deals with the careful investigation of 341 eyes by the measurement of the main refractive components—axial length, corneal power, depth of anterior chamber and lens power (the refractive indices of the refractive media are assumed to be the same for all eyes). Prof. Sorsby and his team have classified their material into two categories, emmetropia ($-0{\cdot}5$ to $+0{\cdot}5D$) and the lower degrees of ametropia on one hand, and the high ametropias (greater than $\pm 4D$) on the other.

In the emmetropic eye they find that the individual refractive elements show a wide range of values, but that a high degree of correlation exists between some of the components. They conclude that the high incidence of emmetropia in the population is due to a high degree of co-ordination in the development and growth of the eye. A similar range of values is found in the lower ametropias, but here co-ordination of the components is imperfect.

In contrast the high ametropias differ from both emmetropia and the lower ametropias in having an abnormality in one component, usually the axial length, for which no amount of adjustment in the other components can compensate. It is concluded that these high refractive errors can no longer be regarded as the result of the intensification of the condition found in low ametropia, but must be regarded as 'pathological'. Further research on this point is clearly indicated.

Several stimulating hypotheses are put forward to account for the high degree of co-ordinated growth found in approximately 95 per cent of human eyes, and a brief account is given of some preliminary experiments on the growth of the rabbit eye designed to test these hypotheses. It has long been believed that there is a hereditary influence on the determination of the refractive state. Some frustratingly brief and interesting preliminary information is given on the genetic aspect of emmetropia and its aberrations.

All interested in this subject will look forward keenly to the results of this team's future research on the growth of the eye in children and animals and to the elucidation of the genetic implications. In this work may lie the final answer to the fascinating problem of co-ordinated growth not only in the eye, where physical size is all-important, but also in the general body structure. F. W. CAMPBELL

* Medical Research Council Special Report Series, No. 293: Emmetropia and Its Aberrations—a Study in the Correlation of the Optical Components of the Eye. By Arnold Sorsby, B. Benjamin, J. B. Davey, M. Sheridan, and J. M. Tanner. Pp. viii+69. (London: H.M. Stationery Office, 1957.) 7s. 6d. net.

PERSISTENCE OF PATHOGENIC STRAINS OF *FUSARIUM* IN BANANA SOILS

IN a further study of the behaviour of *F. oxysporum* f. *cubense* in different soils, R. H. Stover (*Canad. J. Bot.*, 34, 927; 1956) has shown that this organism, the cause of wilt or Panama disease of bananas, tends to diminish in artificially infested soils. Thus, after six to eight months, an initially large population of *Fusarium* obtained by inoculation had fallen to less than 500 spores per gram of soil but could be detected after two years in or around infested glass-cloth strips buried in banana plantations. The apparent differences between population counts in loam and sandy loam are attributed to some defect of the soil dilution plate technique which was used.

The soil plate technique consisted in adding 1 gm. of artificially infested soil to a culture dish, moistening the soil with a suitable nutrient, and observing growth and sporulation microscopically or by estimating colony increases on soil dilution plates. An external source of nutrient was essential for germination and sporulation. Among the nitrogen sources tested, 1 per cent solutions of tryptophan and glutamic acid stimulated the abundant production of spores, whereas inorganic sources of nitrogen were ineffective. Sporulation was greater in soils dried before plating than in soils maintained at 15–35 per cent saturation. Sporulation was greater in acid sandy loam than in alkaline loam and was abundant below *p*H 7·0 in all soils. Sporulation in soil plates was sparse or absent below *p*H 3·5 in acidified loam or above *p*H 8·8 in sandy loam. The optimum *p*H for sporulation in acidified loam was about 5·0 and in sandy loam 5·0–7·0. In general, the rate of disease spread in soils when they are first planted was correlated with soil texture, *p*H and amount of growth and sporulation on soil plates and buried slides. Thus, the soil, rather than the host, appears to be exerting the primary influence on the fungus. It was observed that *Fusarium* grew and sporulated abundantly in decomposing diseased banana pseudostems, on the surface of cut-open rhizomes and in adhering soil, but did not sporulate freely in sap or in the xylem *in vivo*. Fresh banana sap stimulated the abundant production of spores in soil plates. The evidence presented suggests that *F. oxysporum* f. *cubense* also sporulates in Nature in saprophytic association with certain soil–plant components.

STRATOSPHERIC DUST OVER BRITAIN

IT has been known since the eruption of Krakatoa in 1883 that volcanic dust can spread around the world. In July 1953, dust from an eruption in Alaska was seen over western Europe. The latest occurrence of this kind took place at the beginning of April 1956, and is especially interesting for the route taken by the dust. Wing-Commander R. F. Martin, the chief test pilot of the Gloucester Aircraft Company, and his navigator, Mr. P. W. Varley, flying at 50,000 ft. over Gloucestershire between 10.00 and 10.45 a.m. on April 3, saw a layer of 'cloud' off-white in colour and resembling an oily sea some 5,000 ft. higher up. The same evening, Mr. B. Ramsey, of the Meteorological Office, Aldergrove,

Northern Ireland, observed a very high 'cloud' layer at sunset. Flying next morning, Wing-Commander Martin passed through a cloud layer at a height of 40,000 ft. The tropopause was at about 35,000 ft., so this 'cloud' was well in the stratosphere.

The observations agreed closely with those of July 1953, and, in the absence of news of volcanic eruptions, the facts were given to the United States Weather Bureau with an inquiry as to whether there had been an eruption in Alaska. The Chief of the Bureau replied that an eruption of the volcano Bezymannaya Sopka (55° 57′ N., 160° 37′ E.) in Kamchatka on March 30, 1956, had been reported by Moscow radio. Further details of the report, which stated that dust was shot up to a great height, were thereupon obtained from the B.B.C. The Forecast Research Division of the Meteorological Office then examined from upper wind information the problem of whether the very high 'cloud' layer over western Britain on April 3 and 4 could possibly have been the dust of the Kamchatka eruption. Tracking back on the upper air charts at the 100 mb. pressure level (about 50,000 ft.), it was found that the air over Aldergrove on the evening of April 3 was over North Greenland at 9 a.m. on April 2. No information was available from Kamchatka or the Arctic basin at the 100 mb. level, but at the 200 mb. level (about 38,000 ft.) on March 30 the wind over Kamchatka was southerly, 60–70 m.p.h. Supposing that the wind over the Arctic basin at 100 mb. was not very different from this, air at that level over Kamchatka on March 30 would have crossed the North Pole and reached a point a little north of Greenland by the afternoon of April 1. It thus seems very probable that the stratospheric 'cloud' layer was in fact dust from the eruption in Kamchatka which had reached Britain in three days across the North Pole along a track of some 5,000 miles in length.

Details of the eruption and of the determination of the trajectory are given by G. A. Bull and D. G. James in the issue of the *Meteorological Magazine* of October 1956.

ANTIVIRAL ACTIVITY OF GLYOXALS

By C. A. de BOCK, J. BRUG and J. N. WALOP

Central Research Laboratories, Chemical and Virological Departments, N. V. Philips-Roxane, Pharmaceutisch-Chemische Industrie 'Duphar', Weesp, The Netherlands

RECENT reports of observed antiviral activity of compounds with an α,β-dicarbonyl structure[1,2] lead us to submit some results of experiments with compounds of this type and of very closely related ones.

In screening compounds for growth-inhibiting activity towards influenza *A-USA*-47 (*A′* strain former designation *FM*$_1$) a number of α-keto-aldehydes appeared to be active. The experiments were carried out with eleven-day-old embryonated hen's eggs. In each experiment six eggs were used. One hour prior to inoculation of the eggs in the allantoic fluid with 0·1 ml. 10^{-4} dilution of a standard seed virus (*ID*50 about 7), 0·2 ml. of a 0·1 *M* solution or suspension of the compound to be tested was injected into the allantoic cavity. The compounds were dissolved or, when necessary, suspended in saline. After incubating for 48 hr. at 36° C. the hæmagglutination titre of a pool of allantoic fluids from treated eggs was determined. Dead embryos were discarded. A compound was considered active if the difference between the logarithm of the hæmagglutination titre of allantoic fluids from eggs injected with virus and 0·2 ml. saline and the logarithm of the titre of allantoic fluids from treated eggs surpassed + 0·6.

From Table 1 it can be seen that not all glyoxals are active. Compounds with closely related structural features appear to be non-inhibitory in this test. It must be realized that negative results with compounds tested in suspension might have been caused by an insufficient solubility of the compound in the allantoic fluid.

The compounds 3, 4, 17, 20, 21 from Table 1 appeared to be inactive when tested in the following way. A subtoxic dose was injected into the yolk sac of six-day-old chick embryos. After four hours the eggs were also infected in the yolk sac with the virus. Further incubating at 36° C. showed no difference between the mortality of treated and of control eggs (injected with virus and saline).

Investigation *in vitro* of some active compounds (according to Table 1) revealed a direct action on the virus. The virus particles lose their infective power when incubated with glyoxals at low con-

Table 1

No.	Compound	Difference between the log hæmagglutination titres	
1	CH_3—CO—CHO	2·0	*b*
2	*n*-C_3H_7—CO—CHO	0·2	*c*
3	⌀—CO—CHO	0·2*a*	*c*
4	*p*-OH—⌀—CO—CHO	2·0	*b*
5	*p*-OH.*m*-NO_2—⌀—CO—CHO	2·3	*c*
6	*p*-Br—⌀—CO—CHO	0·7	*c*
7	*m*-NO_2—⌀—CO—CHO	2·1	*c*
8	*m*-NH_2—⌀—CO—CHO	0	*b*
9	α-Thienyl—CO—CHO	0·1	*c*
10	α-Naphthyl—CO—CHO	0	*c*
11	*p*-OH—⌀—CO—C(NOH)—H	0·1	*b*
12	CH_3—CO—CO—CH_3	0·4	*c*
13	*i*-C_3H_7—CO—CO—*i*-C_3H_7	0·0	*c*
14	*p*-OH—⌀—CO—CO—⌀—*p*-OH	0·1	*b*
15	*p*-OH*m*-NH_2—⌀—CO—CO—⌀—*p*-OH*m*-NH_2	0·1	*b*
16	CH_3—C(NOH)—C(NOH)—CH_3	0·4	*b*
17	*p*-OH—⌀—CO—C(NOH)—CH_3	0·1	*b*
18	CH_3—CO—COOH	− 0·1	*b*
19	⌀—CO—COOH	0·1	*b*
20	⌀—CH_2—CO—COOH	0	*b*
21	⌀—CH_2—C(NOH)—COOH	0·2	*b*
22	⌀—CS—COOH	0	*b*
23	⌀—C(NOH)—COOH	0·1	*b*
24	*p*-Br—⌀—CH_2—C(NOH)—COOH	0·2	*b*
25	CH_3—CO—$CONH_2$	0·1	*c*
26	α-Thienyl—CO—$C(OC_2H_5)_3$	0·5	*c*
27	*n*-C_3H_7—CO—$C(OC_2H_5)_3$	0	*c*
28	*m*-NO_2—⌀—CO—CH_2OH	0·3	*c*
29	*m*-NO_2—⌀—CO—CH_2—CO—⌀.*m*-NO_2	− 0·3	*c*
30	Cyclohexane 1,2-dioxime	0·5	*c*
31	2-Ketogulonic acid	0·2	*c*
32	Indanedione 1.3	− 0·1	*c*
33	Diphenylparabanic acid	− 0·4	*c*
34	Adrenochrome	0·2	*c*

a, In two experiments with a double dose of this compound, which appeared rather toxic, the differences in the logarithms of the hæmagglutination titre were 1·6 and 1·0.
b, Tested in solution.
c, Tested in suspension.

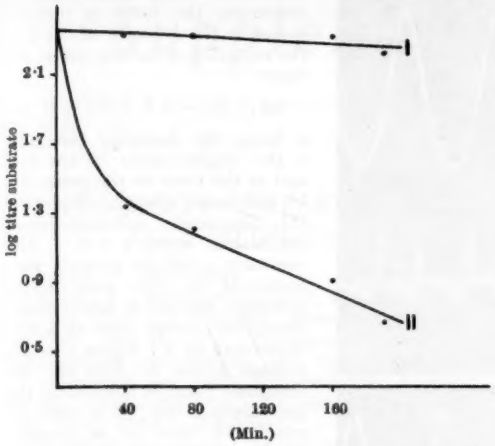

Fig. 1. Action on the substrate urinary mucin of: I, glyoxal-treated FM_1-virus (incubation with 0·001 *M* *p*-hydroxyphenylglyoxal at 37° C. during 24 hr., followed by dialysis against buffered saline for 3 days at 6° C.); and II, control-virus (treated in the same way, but without glyoxal). The hæmagglutination titres of I and II were equal. The substrate concentration was determined as the hæmagglutination inhibition titre against indicator-FM_1

centrations. For example, incubation during 5 hr. at 37° C. in a 0·002 *M* solution of compound No. 1 (Table 1) caused a drop in the *ID*50 from 7·5 to negative values. After 1 hr. at 37° C. a 0·004 *M* solution of compound No. 4 caused a fall of the *ID*50 from 8·5 to 6·0.

Somewhat higher concentrations of the glyoxals destroy the enzymic activity of the virus (urinary mucin as a substrate). Removal by dialysis of the excess glyoxal showed that the particles had acquired the properties of indicator virus (Fig. 1).

The hæmagglutinating power of the virus is destroyed by still higher concentrations or by incubation during a prolonged time. Incubation of FM_1 virus for 6 hr. at 37° in a 0·004 *M* solution of compound No. 4 causes no drop of hæmagglutination titre. After 24 hr. there was a drop in logarithm of the titre from 2·9 to 2·23; after 54 hr. it was less than 1·25. A control shows no change.

The virucidal action is strong enough to explain the activity in the allantoic test. The negative results in the yolk sac test may be explained in different ways. A more detailed description and discussion of the observed phenomena will be published in the near future.

[1] Vashkow, V. I., and Astaf'eva, A. K., Referat Zhr. Khin., Biol. Khin., No. 4004 (1955); *Chem. Abst.*, **50**, 5082 (1956).

[2] Underwood, G., Symp. Div. Med. Chem., Amer. Chem. Soc., June 1956 (*Chem. Eng. News*, **34**, 3557; 1956).

A RELAXATION OSCILLATION MAINTAINED BY DISCHARGE CORONA

By M. I. LARGE

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TRICHEL[1] showed in 1938 that corona from a negative point consists of pulses of very short duration, which often occur at a well-defined frequency. The pulse frequency is roughly proportional to the corona current, and ranges from a few cycles per second to the radio frequencies. A general survey of the subject has been given by Meek and Craggs[2]. I was investigating the radio interference produced by negative corona from the aerial of a radio receiver[3], using point-and-plane geometry, when I discovered a peculiar effect.

When a fine wire point was set up, and strong corona was produced by putting a high potential on the plane, the point often oscillated mechanically, at a frequency near its natural frequency. High-voltage power lines have been observed to oscillate under the influence of corona discharge, and a similar mechanism may be involved[4]. For typical conditions, 5 kV. on the plane, corona current of 10 μamp. and a point consisting of 1 cm. of 48-gauge copper wire with the tip a few millimetres from the plane, the point oscillated so that the tip moved in an ellipse. The size and form of the ellipse depended on the current, and on the separation of the point from the plane. The effect was reproducible, and the oscillation would remain steady for hours on end, often until the point fatigued, and broke. Surprisingly large amplitudes of oscillation could be maintained, the wire sometimes swinging through an arc of more than 90°. By adjusting the potential, very small amplitudes could be maintained. With a wire of circular section, the oscillations were nearly always elliptical, but by using 48-gauge wire hammered into strips, points could be prepared which oscillated in one plane only. Below a certain current, the point would not oscillate. Oscillation could be produced with either negative or positive points.

When a negative point was thus oscillating, the noise heard on the radio receiver was a musical tone at twice the frequency of mechanical oscillation of the point. The point was effectively at an oscillating distance from the plane, so that the discharge current and the Trichel pulse-frequency were oscillating with the mechanical frequency of the point. The note heard on the receiver was the response as the pulse-repetition frequency swept through the tuned frequency of the receiver.

The records in Fig. 1 were taken with a strip point oscillating in one plane. The upper trace is the current from the point, and the lower is the receiver response. The exact form of this response is instrumental. Calibration with a square-wave oscillator showed that the lower trace corresponds to pulses being applied to the receiver at times 0·3 msec. before the peaks on the record. The dotted lines on the figure show this delay.

In *A* the receiver is tuned to 6 Mc./s. It is seen that the pulse-frequency is swept through 6 Mc./s. at a current of about 10 μamp. In *B* the response at 5 Mc./s. occurs as the corona current is swept through 8 μamp., and in *C* the response at 4 Mc./s. is seen to occur as the current is swept through 6 μamp.

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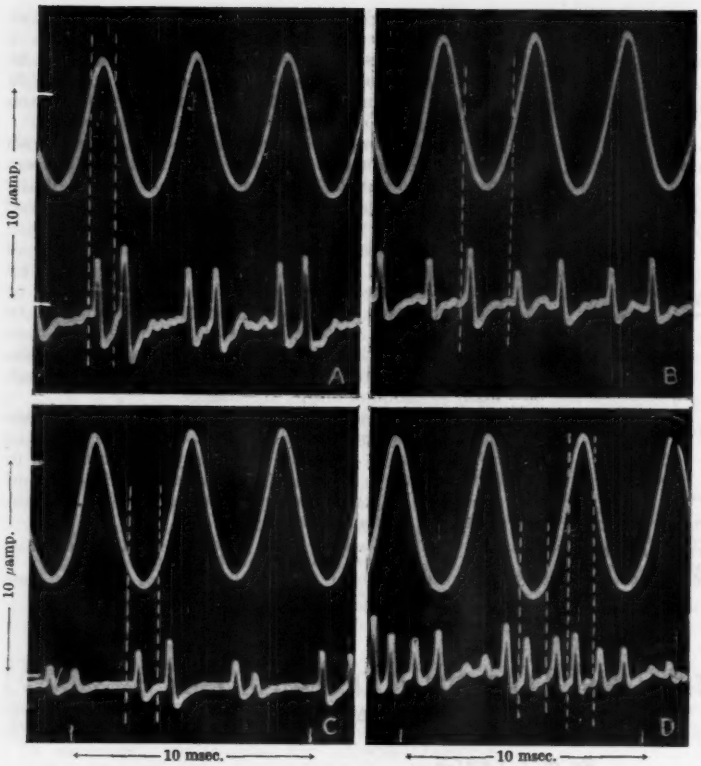

Fig. 1. Simultaneous oscillograph records of the discharge from a mechanically oscillating point (upper trace) and the interference produced on a radio receiver tuned to various frequencies. The Trichel pulse-frequency of the discharge is in the region of 5 Mc./s., and is being swept through a wide range of frequencies by the oscillation of the point. The receiver responds when the pulse-frequency passes through the tuned frequency of the receiver, with a delay of 0·3 msec. The delay is marked by the dotted lines. In (*A*) the receiver is tuned to 6 Mc./s., in (*B*) to 5 Mc./s., in (*C*) to 4 Mc./s. In (*D*) the receiver is at 6 Mc./s., but the frequency swing is more than one octave, and the receiver is responding to the first harmonic of the 3 Mc./s. frequency, as well as the 6 Mc./s.

The effect could be very conveniently demonstrated by tuning the receiver through the stages *A*, *B* and *C*. Outside the range of swing of the pulse-frequency, there is no response from the receiver until the harmonics of the pulse-frequency are reached. In *D* the current swing is so large that the Trichel pulse-frequency swings through more than one octave, and the receiver responds to a pulse-frequency of 6 Mc./s. and the first harmonic of a pulse-frequency of 3 Mc./s., at currents of 9 and 4 μamp. respectively.

This device thus makes a very simple frequency-modulated signal-generator. The fractional swing of frequency is given approximately by the fractional swing of corona current. Like all point-discharge effects, this is subject to variations due to 'change of regime', and the device cannot be regarded as a completely reliable signal generator in its present form.

When the point is discharging in the point-to-plane gap, there is constantly a space charge in the gap which is being cleared by the field between the point and the plane. If the tip is displaced slightly sideways, it moves out of the symmetrical region of space charge, and experiences an electrostatic repulsion in the direction of its displacement. Since the point is discharging continuously, the force on the point will depend on the velocity with which it moves out of the surrounding space charge. Assuming the force is proportional to the velocity of the tip, the equation of motion takes the form:

$$m\ddot{x} + (k - s)\,\dot{x} + ux = 0 \quad (1)$$

k being the damping constant, x the displacement of the tip, and $s\dot{x}$ the force on the point due to the space charge. Equation (1) represents self-maintained oscillation when $s = k$. The constant s will be roughly proportional to the total space charge in the gap at any instant. Since the current rises at a rate depending on V^2, where V is the voltage across the gap, and the clearance time for the ions in the gap depends on V, it may be concluded that s is roughly proportional to V. This explains the observation that a certain minimum potential has to be applied to the gap before the point will oscillate.

This oscillating point is reminiscent of the well-known point-discharge toy in which the 'electric wind' from a set of points around a wheel is used to make the wheel rotate, the asymmetry being introduced by directing the 'points' at the rim backwards. It occurred to me that if the wheel were arranged with the points directed radially, it should be possible to set the wheel in motion in either direction under the influence of the space charge, if the mechanism proposed for the oscillation of the point is correct. It was found that unless very great care was taken to make the points symmetrical, the wheel would rotate in one direction only, determined by the asymmetry of the wheel. However, by using two points on a pivot, in the manner of a simple magnetic compass, and surrounding the 'needle' by a cylinder at high potential, the effect could be demonstrated, and the points continued to rotate in whichever direction they were started. This arrangement greatly reduced the effect of any asymmetry of the points, and allowed the 'velocity dependent' mechanism to control the movement of the points.

Both this and the 'oscillating point' make very pretty demonstration experiments. The oscillating point was demonstrated at the Cavendish Laboratory during the recent celebrations to mark the centenary of J. J. Thomson's birth.

I thank Dr. T. W. Wormell and Dr. E. T. Pierce for their interest and encouragement, Mr. R. Brundish for his valuable assistance, and the Department of Scientific and Industrial Research for a maintenance grant.

[1] Trichel, G. W., *Phys. Rev.*, **54**, 1078 (1938).
[2] Meek, J. M., and Craggs, J. D., "Electrical Breakdown of Gases" (Clarendon Press, Oxford, 1953).
[3] Large, M. I., *J. Atmos. Terr. Phys.* (to be published).
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Supplement to NATURE

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TECHNOLOGY—GREEK, ROMAN AND MEDIEVAL

A History of Technology

Edited by Dr. Charles Singer, E. J. Holmyard, A. R. Hall, and Trevor I. Williams. Assisted by E. Jaffé, Nan Clow, and R. H. G. Thomson. Vol. 2: The Mediterranean Civilizations and the Middle Ages, c. 700 B.C. to c. A.D. 1500. Pp. lix+802+44 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1956.) 168*s*. net.

IT is a great pleasure to welcome the second of the five volumes which will undoubtedly constitute the standard work on the subject. The first volume appeared two years ago and was reviewed in these columns by Dr. F. Klemm (*Nature*, 176, 182; 1955). This work is not only authoritative and well-documented but also very readable. Particularly commendable are the numerous illustrations throughout the book, so many of which are due to Mr. D. E. Woodall.

The division between Vols. 1 and 2, which separates Greece and Rome from the earlier civilizations, is perhaps arbitrary though convenient, but that between Vols. 2 and 3 is more significant, for this volume carries the story to the momentous period at which technology began to be influenced by the rise of modern science. These divisions are not, however, rigidly adhered to. Thus the subject of glass, not treated in the first volume, begins here with Egypt and the civilizations of the Middle East, and the extension of mining into the sixteenth century is obviously made necessary by the existence of Agricola's illustrations; and although printing with movable type began before 1500, that subject has been left for the next volume.

The period between the collapse of the Roman Empire and the Renaissance was on the whole one of technological advance, though retrogression naturally occurred in engineering activities such as public water supply and road building and maintenance, which require political unity and stability. Thus the crank was a medieval invention, and such outstanding advances in textile technique as the spindle wheel or great wheel and the spinning wheel with flyer belong to the same period.

In the first 1,500 years of our era there occurred, however, one of the most important of all technological advances, namely, the utilization of natural forces for motive power. In antiquity the chief source of energy was man's muscle power. The use of the horse did not substantially increase the level of energy production even if it increased the total amount, because the ancients did not know how to harness a horse effectively. The latter was discovered in the Middle Ages. The Greek water mill, also known as the Norse mill, was ineffective and gave no more power than a pair of slaves or a donkey. The Vitruvian water mill and later more effective mills, however, significantly raised the level of power production. The water mill was first used for grinding corn, but owing to the shortage of man-power and the disappearance of slavery at the end of the Roman Empire the use of water-power was extended and water wheels were used for driving saw mills, tilt hammers, fulling mills, and other machines. The harnessing of wind-power was also accomplished in the Middle Ages by the introduction of the windmill, and was more effectively utilized in the improved sailing ships which were able to sail to windward.

The most general discussion of this revolution in power production by the effective harnessing of water, wind and animal muscle is to be found in Prof. R. J. Forbes's chapter on power, which is therefore the key chapter of this volume; but this topic is also to some extent involved in M. B. Gille's chapter on machines.

Prof. Forbes has also contributed chapters on metallurgy, food and drink, and hydraulic engineering and sanitation; and with R. G. Goodchild, on roads, harbours, docks and light-houses. The late C. N. Bromehead contributed a chapter on mining and quarrying; and the late Dr. F. Sherwood Taylor, in collaboration with Dr. Charles Singer, a chapter on industrial chemistry. E. M. Jope has written on agricultural implements, medieval ceramics, and vehicles and harness, and A. R. Hall on military technology, and on military pyrotechnics. There are chapters on leather by John W. Waterer, spinning and weaving by R. Patterson, furniture by Cyril Aldred and R. W. Symonds, Greek and Roman ceramics by Gisela M. A. Richter, glass and glazes by D. B. Harden, the medieval artisan by R. H. G. Thomson, building construction by Martin S. Briggs, fine metal-work by Herbert Maryon, shipbuilding by T. C. Lethbridge, and alchemical equipment by E. J. Holmyard. There are also notes on parchment by H. Saxl, coin stamping by Philip Grierson, windmills by Rex Wailes, and cranes by A. G. Drachmann.

After such a recital of subjects it may appear ungrateful to ask for more; but it is nevertheless a pity that it was not found possible to continue in this volume the subjects of measures and weights, and the measurement of time, especially as this volume is shorter than its predecessor by about the length of a chapter.

A book by so many authors is in danger of lacking unity, but the editors have contrived to bind it together by thorough cross-referencing, and the impression of unity is strengthened by the use of many of the illustrations in more than one context.

This work is confined, of course, to Western technology, but Dr. Singer in the last chapter discusses what we owe to the technologies of the East.

Finally, it should be said that Imperial Chemical Industries, Ltd., by providing financial backing and office accommodation, has made this lavish production possible. Students of the history of technology will share with the editors their appreciation of this great company's enlightened patronage.

K. R. GILBERT

PREHISTORIC METALLURGY OF IRON

Notes on Prehistoric and Early Iron in the Old World

By H. H. Coghlan. (Occasional Papers on Technology, No. 8.) Pp. 220+16 plates. (Oxford: Pitt Rivers Museum, The University, 1956.) 25s.

IN 1951 the Pitt Rivers Museum published as Occasional Paper on Technology, No. 4, "Notes on the Prehistoric Metallurgy of Copper and Bronze in the Old World", by H. H. Coghlan (see *Nature*, 168, 531; 1951). This is now followed by Occasional Paper No. 8, which deals with prehistoric and early iron in the Old World, by the same author. Taken together, these represent what is clearly one of the most substantial contributions yet made to our knowledge of the metallurgical technologies in prehistoric times. Prepared by an engineer, they possess a degree of reality which has not always been present in publications in this branch of knowledge.

It is the second of these, dealing with iron, with which we are here concerned. After a discussion of the nature, properties and uses of meteoric iron, in which a large amount of material is collected and various opinions discussed and correlated so far as this is possible, it emerges that there is still much to learn, and in that process the trained metallographer must play a definitely more important part than has hitherto been allotted to him. As an example, the reader of the present publication might well never realize that the curious twin bands known as 'Neumann lamellæ', which were first discovered in meteorites and which are well recognized in such materials, occur also in synthetic iron and are not, therefore, conclusive evidence of meteoric origin. The early smelting processes which led to a sponge of soft, pure iron are discussed in relation to the types of ore available and the slags which were produced. This stage of the metallurgy is moderately clear. Molten iron could never have been produced at the temperatures which were available, and the 'steel' must clearly have been the result of carburization of such pure iron by a process which, in its essentials, differed little if at all from the production of 'blister' steel, which has become obsolete only within living memory. Damascene steel and the shear steel carving knives of our fathers were the result of the careful and repeated heatings and forgings of such cemented iron. Whether or not cast iron, that is, high-carbon material with a melting point sufficiently low for it to be poured into a mould, was produced until comparatively late times, has perhaps not finally been settled, but there can be little doubt that as a routine product it is a material which played no essential part in the metallurgy of at any rate pre-Roman times. It must not be forgotten, however, that the melting point of a white cast iron containing perhaps 4 per cent of carbon, around 1,150° C., is not so very much higher than that required to melt copper, and that accidental overheating during the carburization process may, on occasion, have led to its production.

One most curious fact which the author develops is that after its first utilization towards the end of the early Bronze Age, iron appears to have suffered an almost total eclipse, to re-emerge in the late Bronze Age. The earliest use of iron, when it must have been a material of considerable scarcity and when, as is not impossible, the major portion of the available supplies was meteoric, was limited in the main to small artistic or religious objects. Early iron, soft, and more or less unreliable mechanically, could have been no very serious competitor to the rapidly developing bronze alloys. As the meteoric supplies were used up, therefore, there would be comparatively little incentive for the production of what must at the time have been both an inferior material and one much more difficult to produce than bronze. With advances in technical knowledge and in particular with increasing appreciation of the improvements to be effected by carburizing the iron and converting it into steel, competition with bronze entered on a new phase, and this in the main explains its reappearance.

One of the difficulties in elucidating the full story of the early history of iron arises from the fact that the design of the furnaces in which the metal was produced is far from adequately known. As a result of weathering and deliberate destruction, the upper part of such furnaces has frequently disappeared, while further, the examination of what is left has rarely been carried out by those with adequate technological knowledge. Despite this, certain general outlines have emerged. Starting with what were little more than holes in the ground, dome-shaped furnaces were developed with an aperture at the top for the escape of the products of combustion and reaction, and with one or more openings at the base through which a blast of air, natural or artificial, could be directed and the semi-solid product of the operation removed. Here consistent lines of development appear to have been followed from the earliest days to the furnaces of the late Middle Ages which bear a recognizable similarity to the relatively gigantic structures with which the modern metallurgist is concerned. The tools of the smith and his technical art are described in detail and with skill, and many readers will be surprised at the quite astonishingly modern appearance of the tongs, anvils, etc., used by the very early worker.

It is possible, however, that the part of the report which will prove of the greatest permanent value consists in the appendix by Mr. P. Whitaker, manager of metallurgical research of Messrs. Stewarts and Lloyds, Ltd., on some sixteen samples of early iron, varying in age from the late eighth century B.C. to about A.D. 900. These samples have been photographed, analysed and examined micrographically with very great care and skill, as a result of which it has proved possible to describe the techniques of production both of the original material and of the particular article examined with a high degree of accuracy and detail.

Taking the two reports together, all those concerned with the early history of the ferrous and the non-ferrous metals owe a debt of gratitude to the author, the Museum and all those who have been associated in any way in their preparation. There are points with which the metallurgist and metallographer will hesitate to agree, but these are not matters of great substance, and do not affect the general picture which has been painted. There is left the vivid impression of a body of men who, over much more than a millennium, were investigating natural phenomena of importance to their communities and were, in fact, the research workers of their time.

F. C. Thompson

STUDY OF THE IONOSPHERE DURING SOLAR ECLIPSES

Solar Eclipses and the Ionosphere

A Symposium held under the auspices of the International Council of Scientific Unions Mixed Commission on the Ionosphere, in London in August 1955. Edited by W. J. G. Beynon and G. M. Brown. (Vol. 6 of Special Supplements to the *Journal of Atmospheric and Terrestrial Physics*.) Pp. x+330. (London and New York: Pergamon Press, 1956.) 140*s*.; 21 dollars.

WHILE it has long been known that the Sun is the primary cause of the existence of the ionosphere, there has been some controversy as to the exact mechanism by which the various layers which reflect radio-waves are ionized. Much information has been accumulated concerning the diurnal variation of conditions in the ionosphere, and the results have been used in a critical examination of the processes of ionization and recombination in the reflecting layers. An eclipse of the Sun clearly provides an excellent opportunity of investigating these processes over a short interval of time, and particularly of studying the relative contributions of radiation from the Sun's disk and from the corona. For these reasons every opportunity is sought by radio-physicists to observe the changes occurring in the ionosphere during an eclipse, especially when the path of totality is accessible and the time is not too near either sunrise or sunset, when the eclipse effects might be masked by the normal daily changes.

In August 1955, certain aspects of eclipse phenomena were discussed at an international symposium organized by the Mixed Commission on the Ionosphere and held at the Royal Society (see *Nature*, **176**, 947; 1955). This symposium was attended by delegates from eighteen countries, and the volume under review contains an account of its proceedings, with the fifty-three formal papers reproduced in full, and brief accounts of the accompanying discussions. The material is presented in nine sections beginning with an introductory survey of "Solar Eclipses and the Ionosphere" by Mr. J. A. Ratcliffe. The second section comprises three theoretical papers on the subject; and this is followed by the third and largest section in which some nineteen papers describe the results obtained in ionospheric observations during recent solar eclipses. Detailed consideration is given in the next two sections to the effect of solar radiation on the ionosphere in conjunction with the processes of recombination, which are surveyed and discussed. The sixth section is devoted to the relationship between geomagnetic occurrences and eclipse phenomena, introduced by a survey by Prof. S. Chapman. In the past decade, the radio astronomer has developed a new tool for studying solar radiation, and the seventh section contains papers describing observations made at short radio wave-lengths in seven countries. After a collection of miscellaneous papers, the volume concludes with a summary in which attention is directed to the evidence, first that the ionizing radiation from the Sun is not uniformly spread over the visible disk, and secondly, even when the disk is totally eclipsed, there is still some 10–15 per cent of residual ionizing radiation in operation.

The production of the work is excellent in every way; it is printed on good quality paper and lavishly illustrated with very clear diagrams and some unusually good reproductions of ionospheric records. The editors, Drs. W. J. G. Beynon and G. M. Brown, have prepared all the papers in as concise a form as possible, and provided a short abstract at the head of each contribution. They have also added a bibliography of all papers on the subject published between 1912 and 1954, arranged chronologically and provided with an author index. This is probably the most comprehensive collection of references in existence dealing with the effects of solar eclipses on the ionosphere, and is a most useful addition to the papers presented at the symposium.

The future research workers and students of this subject are indeed fortunate to have this comprehensive work of reference available, and both the editors and publishers are to be congratulated on its successful production. R. L. SMITH-ROSE

FIELD THEORY AND MESON PRACTICE

Mesons and Fields

Vol. 1: Fields. By Prof. Silvan Schweber, Prof. Hans A. Bethe and Frederic de Hoffmann. Pp. xvi+449. Vol. 2: Mesons. By Prof. Hans A. Bethe and Frederic de Hoffmann. Pp. xiii+446. (Evanston, Ill.: Row, Peterson and Company, 1955.) 8 dollars each volume; 15 dollars the set of 2 volumes.

IT is a reflexion on the present state of physics that in preparing a book on mesons and fields the authors were led to produce one volume on fields and another on mesons, with one of the authors essentially concentrating on one volume, and the other two on the other, with only a very tenuous connexion between the two parts.

Vol. 1 therefore becomes a text-book on field theory, and on closer inspection it is really a text-book on quantum electrodynamics. The reason for this is that the volume concentrates almost completely on the solution of quantum field equations by series in powers of the coupling constant, which is indeed the only procedure that can to-day be applied consistently to give unambiguous answers. It has been very successful in describing the interaction of electrons with the electromagnetic radiation, but it fails completely in the case of meson theory because the coupling constant there is known to be so large that a power series would be practically useless even if it converged (in fact, it is almost certainly divergent). This failure is evident theoretically and also confirmed empirically since the data are in clear contradiction with the results of perturbation theory, a fact stressed clearly in the second volume but apparently not mentioned in the first. Indeed, the statement in the introduction (p. xiv), "We therefore believe that renormalization theory should be considered as substantially correct, and applied to meson theory", may easily induce the reader to think that the methods developed in the volume may be applied directly to the meson field. The remark is probably intended in a more general sense, looking for an extension of the general principles of renormalization to strong interactions, but this is as yet only a very vague programme.

Non-perturbation solutions are mentioned in section 25, but the only results obtained there relate to equations of the Bethe–Salpeter type which go

beyond perturbation theory only in the sense in which a bound system can never be regarded as a slightly perturbed version of the motion of free particles; such equations are still restricted to the case of weak coupling.

Regarded as an introduction to quantum electrodynamics, the volume is very useful. It sets out the formalism carefully and clearly and chooses the approach which would be used in practice by anyone wanting to calculate radiative corrections to some particular process involving electrons and photons. The notation is chosen with care, and the reviewer particularly welcomes the avoidance of the confusing imaginary time variable.

The volume will be less satisfying to a reader who wants to examine the basis of the theory critically. Doubts about the convergence of the series expansion are mentioned only briefly in section 24g, and the question whether, apart from the expansion, the equations have, or can be given, a definite meaning is not mentioned at all. Perhaps this is not quite fair comment, since in the interval between writing and publication (and the interval between publication and review, which the reviewer must confess to be appreciable) such questions have acquired special prominence.

The subject of the second volume, meson physics, is in a very different state of development, and calls for a very different treatment. Except for a brief final chapter, only pion physics is discussed, and at the present stage of knowledge this makes good sense, since it looks as if 'strange' particles do not intervene to any appreciable extent in processes involving mesons and nucleons at not too high energies. One may therefore treat pion–nucleon interactions as an isolated subject, just as electrodynamics is usually treated in isolation. One would hope that a deeper view of physics would ultimately connect these different phenomena, but at present we have no clue to the nature of such a connexion.

The volume sets out the experimental results, and discusses their theoretical implications. As one has come to expect of a book based on a lecture course by Bethe, its approach combines data and theory in an admirable way, using enough theory to make the numbers acquire meaning, without letting theoretical speculation obscure the facts.

The presentation of the data gives a remarkably lucid and complete coverage of the information available at the time of writing. In a subject of this kind any book is liable to date rapidly, but the time was probably wisely chosen. With the main features of the phenomena established, further information must depend on precision measurements which develop more slowly. This does not apply to energies requiring primary particles above, say, 500 MeV., but the interpretation of data in that region is still complex and they are therefore not likely to change the main ideas very rapidly. There are, of course, already some new data available, but they can be fitted into the pattern presented in the book, and for some time to come it will be possible to acquaint oneself with the elements of pion physics from this book and to supplement it by more recent reviews of the latest information.

The book is suitable for an experimentalist with a reasonable knowledge of elementary quantum theory, if he is willing to skip some of the more detailed theoretical sections, and look only at the clear summaries of their results. He may then, however, feel a little bewildered by the profusion of theories, and in doubt as to the degree of confidence (if any) to be placed on the result of any particular calculation.

The various theoretical approaches are presented critically, and the limitations and errors of each are clearly stated. Nevertheless, the outlook (rather characteristic of Bethe) is positive and optimistic; the presentation reflects the view that a calculation even on insecure approximations which yields a number that can be compared with experiment is more valuable than a beautiful equation which cannot be solved. Thus more weight is given to calculations with simple models than to speculations about the properties of the basic equations. It may indeed be true that even if the basic equations of our present theory make no sense (as there is good reason to believe) some of the rough models may survive as being derived not directly from the basic equations, but from guesses based on physical intuition. In any event, even crude theories are often vital to the progress of physics in providing points of view for looking at the data, and guiding further experiments.

This book will evidently remain for the near future an indispensable tool for any physicist concerned with mesons.

R. E. PEIERLS

THIS CHANGING WORLD

Physics in My Generation

A Selection of Papers. By Prof. Max Born. Pp. viii+232. (London and New York: Pergamon Press, Ltd., 1956.) 40*s*. net.

THERE can be few who know so much of the unwritten history of modern physics as Prof. Max Born, who gives us in this book a series of pictures of important events. He has selected for this purpose a number of articles and addresses written during the period 1921–55. Although he is chiefly concerned with the interpretation of modern physics and the change in the climate of ideas, he includes many references to events in his own life and the lives of other great physicists of this century. This feature, very interesting in itself, enlivens the main discussion, which the general reader might otherwise find too abstract.

Space does not permit me to discuss individually the many articles which I admired, but I should like to mention just two. The lecture on "Cause, Economy and Purpose in Natural Laws", originally delivered at the Royal Institution, shows a wonderful sense of economy and purpose in the use of words and illustrations. It is a model of exposition—clear, simple and profound. The account of Einstein's opposition to the implications of the Uncertainty Principle interested me in a quite different way. In this article, Born has to explain a view with which he strongly disagreed. He does this so well that I feel that I understand Einstein better than I did from reading his own paper—though I still agree with Born. We are shown how a scientific controversy can be conducted not only with courtesy, but also with a broad-minded understanding of the other side.

The individual articles are good in themselves, but the book as a whole is more than the sum of its parts. The author has chosen from his earlier writings just those items which represent the outlook of the early 'twenties and he has placed beside them ten lectures and articles written since 1950, in which he expresses very clearly the doubts, the difficulties and

the hopes of the present times. He seeks and he achieves an effect of sharp contrast. This contrast has two aspects. First, there is the difference between theories which presupposed an objective knowledge of a world governed by deterministic laws, and theories in which the distinction between subject and object has become blurred and statistical laws have replaced deterministic ones. Second, there is the contrast between the outlook of a man who, even after the First World War, does not discuss the future of civilization because he has no doubts about it, and the man who after Hiroshima fears—as we all must—the destruction of civilization by nuclear weapons. Yet in 1951 Born does not abandon hope either in science or in mankind—he urges men to learn from natural philosophy that apparently opposed views may yet be aspects of the same truth and to find therein a message of reconciliation and co-operation.

Both the general reader and the physicist will find this an interesting and a stimulating book.

R. W. DITCHBURN

RELAXATION FOR PHYSICISTS

Relaxation Methods in Theoretical Physics

A Continuation of the Treatise "Relaxation Methods in Engineering Science". By Sir R. V. Southwell. Vol. 2. (Oxford Engineering Science Series.) Pp. vii+249–522. (Oxford: Clarendon Press; London: Oxford University Press, 1956.) 55*s*. net.

THERE is a logic in the use of the word 'relaxation' in the title of this book; it is a legacy from some of Sir Richard Southwell's work of twenty years ago on braced frameworks, in which a method was devised involving what he called 'the systematic relaxation of constraints'. The book discusses what has come to be recognized as one of the few, remarkably general, techniques available for the numerical solution of problems of which the underlying mathematical equations have not been, or cannot be, solved in terms of mathematical formulæ. The theory of the relaxation method is beguilingly simple—but in practice physical insight, coupled with considerable patience and energy, are often required to apply it. There is in this field of work no substitute for the judgment which has constantly to be exercised by human computers—electronic computing machines will not assist.

The book now under review is the second and final volume of Sir Richard Southwell's treatise "Relaxation Methods in Theoretical Physics". This and the first volume, together with the author's earlier publication, "Relaxation Methods in Engineering Science", form a record of his work, and that of his co-workers, in the field of numerical processes; further, the books are also a didactic exposition of the technique in which the 'case-history' method has been used throughout. Appreciative reviews of the earlier books have appeared in these columns (*Nature*, **149**, 123; 1942, and **158**, 727; 1946) above the name of Prof. G. Temple.

The basic idea is to replace differential equations by their 'finite difference approximations' and to solve the resulting equations by an iterative process. The function under investigation is specified at a number of regularly spaced points in a plane lying, for example, at the corners of triangles, or squares, or hexagons. Starting with some first approximation to the general solution, the differences between it and the actual values at the specified points are determined, and the values of the differences are reduced systematically by a method of successive approximation which never deprives the computer of his initiative; on the contrary, it challenges him at each step to make the best possible next guess.

As is usual in many branches of scientific inquiry, no one person may with justice be described as the sole originator of the method; the idea of approximating to the differential operation by finite differences is very old; in 1910 Richardson considered the numerical solution of the simultaneous equations so formed; in 1928 Thom discussed the finite difference equations of the Laplace equation; in 1930 Thom, in collaboration with Orr, extended his earlier work, and in 1934 he discussed the biharmonic equation. In fact, in 1924, Hardy Cross propounded, without going into much detail, the elements of a process which he called the 'moment distribution method' which bears a marked resemblance to the relaxation technique. But it is to Southwell and his collaborators that the principal credit must go for effectively devising the method now being reviewed, for giving it a satisfying scientific and æsthetic foundation, and for demonstrating its power by applying it to so many important problems.

Inevitably the problems described in the three books mirror the interests of Southwell and his team, and for that reason deal predominantly with elasticity and hydrodynamics, but the method can, by reason of its generality, be employed in many other branches of physics and engineering. The books are really a guide to the methods to be used in applying the relaxation technique; explicit instructions to a computer would have been of great value, but their inclusion would greatly have increased the size of the books. When using the technique of relaxation it is always necessary to keep an eye on the order of accuracy of the numerical solution. This accuracy can be increased, when required, but the price to be paid is that of the additional computational work involved in reducing the intervals of the finite differences, and of repeating the calculations. Judgment must be used to balance the need for increased accuracy against the time, labour and cost of additional computations. In general, however, the accuracy of non-excessive computations is sufficient for most of the practical purposes of physics and engineering: the method provides solutions which, at the start, serve to reveal general features and which, if required, can later be made to acquire greater definition.

The first chapter of Vol. 2 is numbered seven and continues where Vol. 1 left off. In it the relaxation technique is applied to the solution of the biharmonic equation $\nabla^4 w = Z(x,y)$, in which $Z(x,y)$ is some specified function of x and y. Solutions of the same equation are considered in Chapter 8, and in Chapter 9 the 'two-diagram technique' is introduced as an alternative to the use of the biharmonic pattern. Chapter 10 discusses applications of the two-diagram technique to stress systems in solids of revolution; eigenvalue problems associated with normal vibrations of mechanical and electrodynamic systems are discussed in Chapter 11; the elastic stability of flat plating forms the principal subject of Chapter 12; and non-linear problems in elasticity and hydrodynamics are discussed in chapters 13 and 14. A

number of other developments, such as three-dimensional relaxation, heat conduction, and other problems, are discussed in the final chapter. The book is rounded off with a bibliography concerned with relaxation methods, an index of the sixty-two problems solved in the two-volume publication, a list of the authors mentioned in the book, and a separate index of the topics discussed in the treatise.

The excellence of the printing, of the many line drawings and of the general display makes it necessary to comment once again, even at the risk of appearing monotonous, on the valuable service which the Clarendon Press is rendering to scientists, and to the reputation of British scientific printing, by maintaining its perfectionist standards.

Lastly, a special tribute to Sir Richard Southwell —for the idea, for its development, for the vision to see its great value, and for his three excellent books. Something of the strength of the creative urge to write this last book may be sensed from the fact that the author relinquished his post of rector of the Imperial College of Science and Technology in order to make leisure for himself to complete the work. But perhaps the greatest tribute comes from the work itself—for the ugliness of some of the problems which he describes becomes transformed into elegance when treated by the 'method of relaxation'.

Louis Rosenhead

NUCLEAR PHYSICS FOR THE RESEARCH WORKER

The Atomic Nucleus

By Prof. Robley D. Evans. (International Series in Pure and Applied Physics.) Pp. xv+972. (London: McGraw-Hill Publishing Company, Ltd., 1955.) 109*s*.

PROF. R. D. EVANS is a distinguished physicist, well known for his studies of naturally occurring radioelements and for his work on absorption coefficients and the units and standards of radioactivity. That he is also an outstanding teacher is obvious from this book, in which is assembled the material of lectures in nuclear physics given to graduate students of the Massachusetts Institute of Technology over the past twenty years. At a time when books in this general field seem to be written mainly by theorists, the appearance of a text which firmly adopts the experimental point of view is especially welcome. The reader will, however, not find more than a passing reference to the details of experimental methods; the aim and virtue of this book are to set out, in a clear and unhurried manner, the general principles of the subject, particularly those which are often glossed over or obscured in more hasty treatments of greater scope. The book abounds in precise definitions of terms such as 'radius' and 'cross-section' and should contribute materially to the systematization of nuclear terminology.

The first part of the book is devoted to the main nuclear properties of charge, radius, mass, static moments, parity and statistics. These chapters lead up to discussions of nuclear binding energy, inter-nucleon forces, nuclear models and nuclear reactions. The treatment is careful and thorough, at a level which seems admirable for the general purposes of the graduate student, and there is particular emphasis on the physical interpretation of theoretical ideas. The main theoretical framework is wave-mechanical and the word 'matrix' does not occur in the index. Most of the more important derivations, such as those relating to expansions in partial waves and to barrier penetration, are given in detail, sometimes in appendixes.

In the second half of the book Prof. Evans treats the radioactive-series decay, alpha- and beta-spectra and the interaction of charged particles and of electromagnetic radiation with matter. The chapters on these latter subjects, perhaps because of the author's personal interests, are really short expert monographs and are more highly developed, and therefore somewhat less easy to read, than the earlier parts of the book. The final chapters include useful accounts of the application of statistical methods in nuclear physics, including the fashionable 'chi-square' test. There are tables of constants and appendixes giving formulæ for the centre-of-mass system and for relativistic problems. The book is enriched by an impressive collection of useful exercises and problems, many of which themselves contain new and interesting facts.

The reader can scarcely fail to admire the care and thought which Prof. Evans has bestowed on this work, and he will probably put down the book with a feeling of regret that even in nearly one thousand pages it has still not been possible to touch on anything like all the manifold divisions of the subject. The title is carefully chosen, and the exclusion of practically the whole vast area of high-energy physics is perhaps to be expected, but the student might have hoped for more guidance regarding the theoretical spectroscopy of light nuclei or the interpretation of reaction data according to the shell models. Lifetime determinations and Coulomb excitation processes are also among the subjects which should figure in a future edition. The topics included are, however, the important ones and the research worker proceeding to his more narrow specialization will be grateful to the author for the sound foundations laid in this volume. The book has gained much from the labours of two decades of students and appears, at first reading, to be wholly free from errors. Pedagogically, its publication is an important event for the nuclear physicist in training, but its appeal as a general handbook should be much wider and most workers in the subject may expect to derive pleasure and profit from reading it.

W. E. Burcham

BASIC IDEAS IN TOPOLOGY

Elementary Topology

By Prof. Dick Wick Hall and Prof. Guilford L. Spencer. Pp. xii+303. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1955.) 56*s*. net.

Topology

By Dr. E. M. Patterson. (University Mathematical Texts.) Pp. viii+128. (Edinburgh and London: Oliver and Boyd, Ltd.; New York: Interscience Publishers, Inc., 1956.) 8*s*. 6*d*. net.

THESE two books deal with the elements of topology for the undergraduate in an honours course, and have much ground in common; they are, however, to some extent complementary, one to the other. A novice reading Hall and Spencer might end with a respectable knowledge of the jargon and

techniques of the subject and yet fail to understand what topology is. Patterson's book is much smaller and therefore omits more, but takes great pains to give ideas the preference over technique.

In Hall and Spencer, we start with a certain amount of classical set theory and analysis, with a topological motivation, and proceed to a neat characterization of topological spaces, followed by a special study of metric spaces. Most of this has an analytical flavour; but the next chapter, the longest in the book, is rather more geometrical, analysing the nature of arcs, Jordan curves, and the concept of local compactness. This section is detailed and clear, as befits a topic of such basic importance. The following section, on Bing's recent work on partitionability, is less easy to assimilate, and being highly technical is almost out of place in a professed introduction. The final chapter is in the nature of an appendix on the axiom of choice and the equivalent lemma of Zorn. There is a good collection of examples, easy and not so easy, for the student, and a useful short bibliography is attached to each chapter. The road everywhere has a good surface, but more signposts would help the novice.

Patterson begins with simple concrete ideas: topological equivalence, one-sided and two-sided surfaces, Euler's theorem on polyhedra, the four-colour problem. Then a little set-theory leads to metric spaces, which in turn lead to the more general topological space. The homotopy problem, of continuous deformation of one sub-space into another, is clearly described. Then algebraic topology, practically ignored in the Hall and Spencer volume, is developed in two chapters, one on simplexes, the next on homology. The latter is perhaps too concise for ready understanding, and might well be expanded in a new edition. There are a fair number of exercises for the reader. The great merit of the book is that it tells the reader what topology is about, in clear and generally simple language; it will help not only the undergraduate but also the non-topological mathematician who wants to know what topology is and why it is important. T. A. A. BROADBENT

THE MIND–BODY PROBLEM

The Biology of the Spirit

By Dr. Edmund W. Sinnott. Pp. ix+180. (London: Victor Gollancz, Ltd., 1956.) 16*s.* net.

DR. E. W. SINNOTT has written one more essay on the perennial mind–body problem, but this would be an unfair way of describing what he has given us, because it is distinctly original in character and, owing to the point of view from which it is written, opens out wide issues. His book may, in fact, be said to begin with protoplasm and end with beauty, goodness and God. The main thesis of the essay is that the basic facts of biology provide a common foundation for both mind and body.

Dr. Sinnott is not a vitalist, though he considers that the facts on which Driesch based his vitalist theory have not been, and probably cannot be, interpreted by a mechanistic hypothesis. He rejects the view that biology can understand living processes by employing solely the concepts which are adequate in physics and chemistry. One of his two master words is 'organism', and the chapter in which he expounds this conception and the reasons for regarding it as fundamental are clear and well argued. In this section of the book, the central problem is that which Walter de la Mare once stated in the words, "Why does what Miss T. eats become Miss T. ?" and is essentially the same as that which Aristotle tried to solve in his philosophy of matter and form. "A living body is not an aggregate but an integrate" and in it the whole is, in some way, immanent in the parts. The other master word in Dr. Sinnott's essay is 'purpose'. He holds that it is misleading to think of living creatures being "propelled by drives", and we have a more accurate picture when we regard the forces as 'pulls'. He describes his own view as telism, the philosophy of goals—"a belief that what is important is not the push and drive of a living system but a drawing power to a goal conscious or unconscious that in some way is established in it". The later chapters of the book deal with the development of the human individual and goals and purposes which have emerged in human personality. In his view, the process by which protoplasm and spirit are linked together is a continuous one, but in its course a new level of life is attained.

In the final chapters, which the author undoubtedly regards as the most important, we are, of course, in the region of philosophy, and he does not pretend that he can give a scientific proof of his conclusions. He argues, however, that a survey of the phenomena of life in their whole range strongly suggests that the organizing and forward-moving qualities found in life indicate the nature of reality and help us to link our values and our faith in God with biology. "If all the goal-seeking, desiring, and aspiring of our spirits are but curious tensions in a protoplasmic mechanism, they are still of interest and importance in many ways; but if, beyond all this, they provide a means of communion with something in the universe that can be apprehended in no other way, then does their significance indeed transcend all other human qualities."

Dr. Sinnott believes that the fundamental problem is the nature of life and that, by concentrating on this, we may hope to reach an understanding both of matter and of mind and of their relations with one another. It cannot be said that Dr. Sinnott has done much more than point a possible way and made some important observations. Matter and mind, thought and things remain obstinately different, but it may well be that the solution lies along the way which he has pointed out. W. R. MATTHEWS

BRAINS: REAL AND ARTIFICIAL

Automata Studies

Edited by C. E. Shannon and J. McCarthy. (Annals of Mathematics Studies, No. 34.) Pp. ix+286. (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1956.) 32*s.* net.

THIS volume contains some dozen essays, by American and European authors, on the general theme of brain models. The work is mainly mathematical in character, and presents the opinions of well-informed, and mostly well-known, writers in the field whose general aim is to answer the question: "How does the brain work ?" so far as this can be answered within the limits of modern scientific knowledge. Such knowledge is contributed from

several disciplines: mathematics, physiology, psychology, logic and engineering.

Modern brain models are very sophisticated. Whereas years ago brains were compared to telephone exchanges, a comparison so admittedly naïve that few people regarded it as having any philosophical interest, to-day the sophistication is such that many serious-minded people fail to understand either the nature or the purpose of this work. Purpose in science is important. In the reviewer's opinion, the aim and purpose of brain models are to integrate into a consistent scientific description the various known behavioural properties of the animal brain, as a conceptual aid to biologists, so that relationships between various modes of behaviour may be studied, hypotheses tested, and precise expression formulated where only descriptive notions have existed before. In fact, such models are exactly on a par with other scientific models in, say, physics.

I emphasize here *behaviouristic* aspects. Words like *think* or *know* or other cognitive language are wholly out of place in this particular context (though, of course, they are of prime concern in other contexts).

This volume has wisely been entitled "Automata Studies", for its scope is wider than a title such as "Brain Models" might suggest. For in this whole field of interest there are two domains which, in my opinion, it is absolutely essential to distinguish. It is good to see that the volume has been sectioned accordingly; the two fields are describable as follows.

The first is concerned with mathematical computers, *per se*, both conventional and new, especially to examine what they can and cannot do in principle. The relevant question here is: "What is a machine-like task?" The papers falling within this field make no specific reference to biological data. The second field concerns models of the brain, and the relevant question is: "What is a brain-like task?" It may be answered, though this is not always the case, by those who are not primarily concerned with the first field. One point of value in this present volume is that it contains work from both fields and thus is a useful comparative study.

Not only should we ask: "What is a brain-like task?" but also: "What is a brain-like way of executing it?" For brain models to be useful they must conform closely to neurophysiological principles.

Truly, once a scientific description of brain operation has been made, it might be programmed for a conventional digital computer—but such a form of representation would serve little purpose in research. The question of brain-like modes of action involves judgments by human observers; that is, it involves expectations of what the animal or human would do on such and such an occasion. *Criteria* of behaviour are required (as, for example, Rossum's criterion of human behaviour was his robots' fearful protests against being sent to the crushing machine as scrap*).

Throughout this volume, in both the essays concerned with machines and their logical possibilities, and those concerned with representations of brain-like behaviour, one senses a certain universality of concept. Machines are described as having certain states, which are changed according to input *stimuli*. They are constructed as random or partially ordered nets of identical and simple elements, with well-defined properties. Sometimes these are in deliberate imitation of Nature (neurons), sometimes quite contrary to Nature, according to the two fields of interest.

* Karel Capek's play, "R.U.R.".

One paper displays a philosophical point of view which may well arouse fierce discussion (Culbertson, p. 99). This claims that given enough model neurons, enough space and time of assembly, a robot could be built indistinguishable in behaviour from John Smith. Are we so near Rossum? Is the sheer economy of Nature its great distinguishing characteristic?

Colin Cherry

WILDERNESS ECOLOGY

Wild America

By Roger Tory Peterson and James Fisher. Pp. 416. (London: William Collins, Sons and Co., Ltd., 1956.) 30*s*. net.

Pelican in the Wilderness

A Naturalist's Odyssey in North America. By F. Fraser Darling. Pp. 380+15 plates. (London: George Allen and Unwin, Ltd., 1956.) 25*s*. net.

MOST Europeans (and, I suspect, many Americans) are unaware of the vast extent of American wild Nature, of the problems it poses and the opportunities it provides. These two interesting and well-written books deal with it, though from different angles. Though the two treatments overlap, Peterson and Fisher are primarily concerned with the huge area of untamed Nature with its abundance of wild life still to be found in North America (in sharp contrast with Europe), while Fraser Darling deals chiefly with the problem of land use in the wilderness and the sub-wild areas.

"Wild America" sets out to describe a 25,000-mile journey through the wilder areas of North America, mostly within the United States, but with excursions to Mexico and Alaska. For each step of the journey Peterson effectively sets the scene as an old stager, and Fisher records the vivid impressions of a newcomer who is also an experienced naturalist and traveller. Though, as is to be expected from two distinguished ornithologists, the birds get favoured treatment, plenty of attention is given to scenery and geology (Fisher's description of the Grand Canyon is outstanding), to the mammals (in which North America is still so rich), and to other groups, including the human—the Indians of the south-west, the Alaskan Eskimo, and the modern Americans.

Perhaps the most important sections of the book are those dealing with the National Parks system and the various agencies concerned with the conservation of Nature and wild life, and rather bitterly but justifiably contrasting American achievement in this field with the British. In Britain there are the admirable Nature Conservancy and the Forestry Commission. But these are dwarfed by the U.S. Fish and Wild Life Service, the activities of which extend throughout the country, and by the U.S. Forestry Service, which controls and safeguards enormous areas of woodland and undertakes a great deal of research. However, it is over National Parks that Britain comes off worst. In Britain, the Hobhouse Report was emasculated, so that the National Parks are little more than camouflaged local parks, supervised but not controlled by a National Parks Commission without adequate powers or finance. There is nothing like the U.S. National Parks Service with its admirable rangers, guide-lecturers and pamphlets, its camp-sites, picnic sites and other amenities

for visitors, and one can pass through any park area in Britain without ever discovering the fact that it is a National Park.

In the United States, the citizen has been made aware of the parks as a national asset: as Fisher writes, the park visitor leaves "satisfied, refreshed, emotionally stirred, and with another stake in America". As a result, there is scarcely a trace of vandalism, or even of litter: the National Parks Service has educated the public to appreciate its heritage of Nature.

But the book offers much else. As I read I recalled how, years ago, I was made to realize the continental vastness and variety of the U.S.S.R. when Bukharin told me in Moscow that he was going to spend his leave shooting tigers on the Amur River. Peterson and Fisher bring home in much greater detail the same fact about the United States, with their admirable descriptions of the tropical Everglades, the coral islands off the Florida coast, the deserts of the south-west, the Big Trees and the sea-otters of California, the scenery of the Rockies, the rain-forest of the Olympic peninsula, and the arboreal riches of the Great Smokies temperate forest, unparalleled except perhaps in western China.

I was delighted with their informative account of the Navajo and Hopi Indians, and properly envious of their record tally of 601 bird species seen in just over ten weeks.

Naturalists will find much to interest them—the arrival and rapid spread of a new species, the cattle egret, in North America; the dependence of that curious bird, the limpkin, on a giant species of water-snail; the evolution of distinct sub-species on either side of the Grand Canyon; the survival as a member of the American fauna of an African butterfly introduced in the fodder of the camels brought in by Jefferson Davis as military transport; the fact that the British wren is the one species of the wren family which has colonized the Old World; the dwarf sub-species of white-tailed deer on the Florida Keys; the unique colonial habits of the tri-coloured redwing; the tool-using propensities of the sea-otter; and much besides.

Fraser Darling covered almost as much ground; but he was travelling on two assignments, one on human ecology for the Rockefeller Foundation, the other on wild-life ecology in Alaska for the Conservation Foundation. He, too, gives a vivid and well-written presentation of the great areas of North America which are virtually unknown to Europeans (in the process revealing his own unusual and sympathetic personality). He tells us of the work of the Federal Bureau of Lands, the U.S. Fish and Wild Life Service, the National Parks Service and the Forest Service, of some of the great conservation projects (like the vast Bear River wild fowl refuge), of the leading figures concerned with conservation (like the Leopolds, Marston Bates, Paul Errington, H. L. Shantz, Fairfield Osborn, Paul Sears and W. J. Hanson) and of the many dedicated field-workers he met in the wilderness; and once more the European is struck by the magnitude of the American effort and achievement.

He has interesting things to say on the Alaskan Eskimo, on the Mexican peasant, on New York City as the modern equivalent of Alexandria and on Paul Bunyan as the legendary Hercules of America, on Williamsburg, that marvel of reconstruction, on the splendid trees of America, and on the botany and zoology of its forests, prairies and deserts.

Here are some titbits from his store: in some regions the gopher takes over the ecological role of the earthworm; large numbers of moose are killed by trains in Alaska because of the abundance of browse along the railway lines; in Alaska you can see some of "the last meat-fed savages on earth"; the pika or rock-rabbit deliberately makes hay in the summer to store against winter food-shortage; the natural regeneration of brush in some semi-desert regions depends on the antelope ground-squirrels, which make innumerable little caches of bitter-brush seeds and then forget them; an area of low coastal tundra in Alaska, "empty of men except for a very few Eskimo families", is as big as mainland Scotland; in the Grand Canyon National Park, deer which visit dustbins make more litter than the human visitors. . . .

But the main interest of the book is ecological. Thanks to his long experience of the Scottish Highlands and their human problems, Fraser Darling was enabled to see in Alaska a picture of what the Highlands and Islands must have looked like when "emerging from the ice through a few thousand years". Knowing how man had managed to convert much of the Highlands into an ecological desert, he could prophesy a similar desertic future for various areas in the United States if present tendencies are not checked.

In the United States, as in Scotland, running sheep on marginal land seems to be one of the major causes of ecological impoverishment, leading to over-grazing and deterioration of pasture type; this, coupled with the irrational killing of predators, leads to multiplication of undesirable rodents, and often to irreversible erosion.

American experience and research are illuminating the entire predator problem. Thus it is now clear that wolves are beneficial to deer, not only by preventing over-multiplication (on the Kaibab plateau, once the wolves and mountain lions were exterminated, the deer ate themselves out of abundance to near-starvation and scarcity), but by keeping them on the move and so preventing them from local over-browsing. Some authorities, indeed, are beginning to think that predator-control is rarely useful and often deleterious.

One of Fraser Darling's novel conclusions is that the best 'crop' for many areas is the wild life—moose and deer, musk-rats and wildfowl—while to try to raise cattle in the moose areas of Alaska is to invite financial and ecological disaster. Similarly, the pastoral policy of grazing sheep on marginal pastures, especially those with underlying limestone, will convert them into barren pavements (as has probably happened in northern England) or xerophytic sub-deserts; while over-zealous ploughing, especially in arid regions, leads to loss of soil: in spite of the lesson of the 1930's, this has now produced a new dustbowl over huge areas of the South-west.

He has a good deal to say about the mystique of farming—the almost religious belief in the rightness of converting as much land as possible to agricultural production, whether by ploughing, grazing or ranching. This (and the farmers' pressure-group) is especially strong in the United States, where a mystique of homesteading is also prevalent; but Fraser Darling had to contend with it in the Highlands, which "are being used to produce protein in the shape of meat and wool, when the climate and physiography dictates cellulose-production as the main activity". This is clearly disastrous for marginal land; but Darling goes further and maintains

that (in the present economic set-up) "agricultural or pastoral prosperity means accelerated ill-treatment of land".

This last phrase reveals his central approach. We have to think less about farmers and produce, more about the land. The land is man's basic resource. We must apportion its use not only according to our various human needs, but also according to its varying capacities of continuing yield, whether that yield be of food, wild life, timber, or recreational space. Above all, we must see that its yield capacity, of whatever sort, is not reduced (or even totally lost) by faulty or short-sighted exploitation. Man must learn to love the land, and to respect it.

This issue looms much larger and is being more thoroughly debated in the United States than in Western Europe, with its agriculturally propitious climate; but it is a fundamental issue for the world as a whole. We should be grateful to Fraser Darling for having brought it to our notice in such an arresting way. JULIAN HUXLEY

PERSPECTIVE IN GENETICS

General Genetics

By Prof. M. J. Sirks. From the fifth Dutch edition, translated by Dr. Jan Weijer and D. Weijer-Tolmie. Pp. viii+628+5 plates. (The Hague: Martinus Nijhoff; London: B. T. Batsford, Ltd., 1956.) 70*s*.

Genetics

The Modern Science of Heredity. By Prof. Edward O. Dodson. Pp. vii+329. (Philadelphia and London: W. B. Saunders Company, 1956.) 45*s*. 6*d*.

THE key to the merits, and possibly to the shortcomings, of "General Genetics", by Prof. Sirks, is found in the preface. Here the author discusses, with considerable justification, the tendency in some recent text-books to give insufficient attention to the pioneer work. As Sirks puts it, "Modern textbooks seem to suggest that for Genetics 'Life begins at forty' ". The stated aim of this book is "to establish an equilibrium between Genetics as it was built up before 1940, and Genetics as it has developed since".

Throughout the volume the reader is led through the early work, which is presented, sifted and weighed with delightful care. In particular, the account of pre-Mendelian theories is stimulating. The shortcomings of the book lie mainly in the treatment of some of the post-1940 material. The chapter dealing with the nature of genes is very uneven in quality. Here, many statements are ambiguous and some quite misleading. In dealing with extra-nuclear inheritance only half a page is allotted to the discussion of kappa while the antigens of *Paramecium* and respiratory enzymes of yeast are dismissed with only a reference. This will seem to many to be an over-correction of historical perspective. Further, in a brief discussion of bacteria Sirks writes of the absence of 'pure lines' and states "it is also not permissible to speak of bacterial mutations". Such statements surely give too little credit to the bacterial genetics of the past decade.

The book covers much of what might be taught in a first-year course, though its historical coverage is far greater than could be grasped by a student in one year. For this reason, and because of its weaknesses in dealing with some of the more recent advances, the text-book will have a limited appeal for any but the most earnest student. Nevertheless the book will be welcomed by geneticists. The author has marshalled an immense amount of information and the extensive bibliography is excellent. The careful and comprehensive treatment of the early work of genetics, together with a good index, make this a unique reference book. As such it forms a very valuable addition to the literature of genetics.

"Genetics, the Modern Science of Heredity" is written primarily as a text for a first course. It covers the expected range from the laws of Mendel to physiological genetics, cytoplasmic inheritance, genetics and evolution and so on. Treatment of some aspects is rather scanty and one could, for example, have wished for a fuller account of genetics and evolution. However, the author may have felt that his terms of reference dictated such brevity. A brief historical account of genetics and a translation of Mendel's famous paper form two appendixes. A third appendix suggests laboratory exercises.

The basic principles are presented rigorously; the terms of genetics are, with a few exceptions, well defined; experimental findings and deductions from these findings are clearly set out. It is typical of the author's approach that the *CIB* test, which is often a temporary stumbling block for many beginners, is explained with perfect clarity. In each chapter Dodson has presented plenty of hard facts to be grasped and he draws cautious conclusions from them. But at no point does he close the door to further argument. This technique provides a satisfying account which avoids an excess of controversy and yet is not over-simplified. Well-chosen references for further reading are given at the end of each chapter. Illustrative examples from a refreshingly wide range of organisms are provided and the many drawings and photographs are well reproduced. A minor fault of the book lies perhaps in the author's desire to present a pleasing text. Generally he has been highly successful but occasionally one senses an over-anxiety to please. A few of the analogies are naïve and irritating; in a few instances the author is too dogmatic and at times one detects an excessive attempt to 'sell' the subject. This applies particularly to the chapter on human genetics.

Despite such minor faults, Dodson's aim is well fulfilled and his book will provide an excellent text for a first course of genetics. J. A. ROPER

A NEW MONOGRAPH ON THE LINYPHIINAE (ARANEAE)

Die Tierwelt Deutschlands

Teil 44: Spinnentiere oder Arachnoidea (Araneae). Von Dr. Hermann Wiehle. Pp. viii+337. (Jena: Veb Gustav Fischer Verlag, 1956.) 38 D.M.

THE first volume on spiders (Salticidae) in this monumental series on the German fauna was published in 1926 by Friedrich Dahl, who founded the "Tierwelt Deutschlands". Further volumes, mainly by different authors, followed in the succeeding years dealing with other families, and in 1956, the centenary of Dahl's birth, this important addition by Dr. Wiehle on the family Linyphiidae was published. Although the group covered by this

volume is given family status, following Dahl, the practice followed in the recent Ray Society monograph on "British Spiders" by G. H. Locket and A. F. Millidge is to rank it as a sub-family, which together with the larger Erigoninae form the Linyphiidae. In German literature the Erigoninae of Locket and Millidge is ranked as a family under the name Micryphantidae.

Whether regarded as one or two families, this large and complex group of spiders has for long been very inadequately monographed in European faunas. The only modern work is by the above British authors, so that Dr. Wiehle's work is particularly welcome. Wiehle follows Locket and Millidge in the features which separate the two main groups, but he points out that there are several transitional genera so that separation cannot be complete. He believes that the Linyphiids evolved from the Micryphantids (Erigonids) and mentions various biological distinctions between the two groups, for example, broad divisions of habitat preferenda and web types.

As in previous monographs by Dr. Wiehle, there are many large and clearly drawn illustrations of structural features. He places considerable emphasis on the form of the vulva, which he says should be as well understood by the student as the epigyne. The females of some closely related species can only be distinguished by examination of the vulva.

A key is provided for the six divisions recognized by Wiehle in the family and also for the genera and species. In general the arrangement of genera follows closely that of Locket and Millidge, but there has been some generic splitting. The species in the genus *Linyphia* of the British monograph are to be found in three genera called by Wiehle *Prolinyphia*, *Linyphia* and *Microlinyphia*.

Dr. Wiehle's work will undoubtedly be widely used by British araneologists and serious consideration given to his new ideas on the taxonomy of the group.

There is a genus and species index and references to the literature consulted precede his general introduction.

ERIC DUFFEY

ECOLOGY OF FUNGUS–HOST RELATIONSHIP IN SOIL

Biology of Root-Infecting Fungi

By Dr. S. D. Garrett. Pp. xi+293. (Cambridge: At the University Press, 1956.) 30*s*. net.

THE investigation of root-infecting fungi has proved extremely difficult because the roots are in the soil, which is a complex ecological association in which not only the pathogen but also a great many other micro-organisms are in precarious equilibrium. Dr. Garrett points out that the study of root-infecting fungi has passed through a number of phases; the etiological phase when research was directed to proving that certain fungi were causal organisms in specific diseases; the environmental phase when research was concerned largely with the effect of the physical environment on disease development; and finally the present phase in which root disease is studied as an aspect of microbial ecology. It is in this last phase that Dr. Garrett has made his distinctive and distinguished contribution. This book brings together his mature views on the whole subject.

The fungal flora of the soil is reviewed from the ecological point of view and the distinction between normal soil inhabitants and soil invaders is emphasized. The significance of competition for organic substrates in soil is explained. The growth habit of parasitic soil fungi is examined and a biological classification of these, ranging from primitive unspecialized types to the symbiotic mycorrhizal fungi, is put forward. The significance of mycelial aggregation into strands and rhizomorphs is discussed with special emphasis on fungal growth on the root surface (the ectotrophic habit) prior to penetration in certain important species. A brief chapter on mycorrhiza is concerned with showing that the difference between ectotrophic mycorrhiza and root disease fungi is one of degree and not of kind. Rhizosphere and root surface floras are considered in relation to root infection.

Much attention is given to the saprophytic life of pathogens, particularly in relation to the active saprophytic colonization of substrates in the soil and to survival in dead host tissue. The biology of resting spores and sclerotia is given full consideration. There is a general discussion of the epidemiology of root diseases and the effects of the environment are stressed. Finally, the principles, both biological and economic, governing the control of root diseases are outlined.

The feature that really distinguishes this book is the successful attempt by the author to synthesize his unique first-hand experience and his vast knowledge of the literature into a coherent whole. The book is written clearly and in a vigorous style. It has a philosophic air about it which will commend it not only to mycologists with an earthy interest but also to all mycologists and, indeed, to botanists generally. It is full of suggestive ideas, many of which have a relevance far beyond the soil.

The work has been condensed from Dr. Garrett's unique knowledge. Some mycologists, not themselves working on root disease fungi, might, perhaps, have welcomed an even greater condensation so that the essential ecological and biological principles developed by the author might have shone forth with even greater brightness. But this is a small criticism. There can be no doubt that the author has contributed a book of outstanding mycological importance which will have a most significant bearing on future research on soil fungi.

C. T. INGOLD

THE NATURE OF DELUSIONS

Schizophrenia 1677

A Psychiatric Study of an Illustrated Autobiographical Record of Demoniacal Possession. By Ida Macalpine and Richard A. Hunter. (Psychiatric Monograph Series.) Pp. ix+197+12 plates. (London: William Dawson and Sons, Ltd., 1956.) 130*s*.

DELUSIONS have always had a strong fascination, not only for the general public to which they are inexplicable, but also to the psychiatrist who tries to unravel their nature and causation. There is an uncanny strangeness about them which arouses deep-seated horror. The apparently astute business man, the happy wife, or the successful student starts to talk and write in a way which reveals that he or she has lost touch with the real world. A belief in strange plots attributed to Freemasons,

or Catholics or some other minority reveals itself. At other times it is felt that the subject has been chosen by the Deity to lead mankind along some special path or even become the Deity Himself. In others curious changes are felt in the body—men believe that they are pregnant, changing their sex, or have some impossible event occurring (as General Blücher believing that he had an elephant in his side).

The problem does not end here. Delusions can be caused by obviously detectable mental disease, such as syphilitic encephalitis or cerebral tumours, and sometimes the nature of the delusion can be related to the point of injury. One might say, as some try to do, that delusions are merely the symptoms of cerebral damage. This would be supported to some extent by the fact that toxins can in some circumstances produce exactly the same type of false ideas. Yet such an attribution is disproved by the fact that some patients develop delusions (sometimes with hallucinations—such as hearing 'voices') which have no discoverable organic basis. These may last for a brief period and then disappear as the patient recovers. There seems little evidence in such cases that the causation was organic; they must be regarded as some disturbance of the psychology caused by inner or outer stress.

It is especially valuable, therefore, when we can obtain an account written by the patient himself describing what has happened to him. This occurred in the case of a German judge, *Senatspräsident* Dr. Daniel Paul Schreber, who believed that he was the "sole survivor of mankind", suffered from "soul murder" and was being transformed into a woman. Freud analysed the document he published and concluded that his illness was a defence against homosexual urges. He built up the psychoanalytical theory of paranoid psychosis on this basis.

The present book describes another case, also analysed by Freud, which was that of Christoph Haizmann, an artist who lived in 1677. This man had the delusion that he had sold his soul to the Devil and was only relieved of his symptoms when he managed to recover the pacts in the fiend's possession at the shrine of Mariazell.

This book gives coloured reproductions of Haizmann's paintings and a photostat of the original documents describing the course of his malady. There are translations of the various documents and a careful analysis of the whole matter. The authors discuss it in relation to the case of Dr. Shreber and comment on psychoanalytical theory. They put forward their own ideas on causation.

The only unfavourable comment one can make is that it is a pity that this most valuable book has been made too much a vehicle for the authors' theories, which are at times at variance with most psychiatric teaching. Once or twice it is not easy to understand their ideas, particularly over the relationship of procreation fantasies and homosexuality. One is at loss to know what is meant by "Lallemand's male patient who wrote love letters to a man was, psychologically speaking, showing heterosexual behaviour".

However, this book is recommended to all those interested in psychiatry. There is no other translation of the original documents, and the painter's own account of his psychosis is most interesting. The paintings of the Devil are worth study. The book is well bound in beige cloth, the paper is good and there is a good index. Clifford Allen

THE HUMAN EYE

Documenta Ophthalmologica

Advances in Ophthalmology. Edited by G. von Bahr, J. ten Doesschate, H. Fischer von Bünau, J. François, H. Goldmann, G. Lo Cascio, H. K. Müller, Jean Nordmann, A. J. Schaeffer and Arnold Sorsby. Vol. 10. Pp. iv+382+10 plates. (The Hague: Dr. W. Junk, 1956.) 92 guilders.

"DOCUMENTA Ophthalmologica" has now come to its tenth volume, and it seems a suitable opportunity to comment on the value of the publication as a whole. The aim it fulfils is to assume responsibility for publishing papers of a more scientific type than is acceptable to most clinical journals and of a more elaborate type than can be brought within the compass of most scientific journals. The present volume is typical of the way in which it fulfils its end.

The first, and the most interesting, contribution from the scientific point of view is a discussion of the pupillary reactions by Schweitzer, of Utrecht, in a paper which occupies seventy-eight pages. It is a good paper describing original work in which the pupillomotor reactions were studied by infra-red photography, a method which allows the activity of the pupil to be recorded continuously and directly without interference with pupillary movements due to visible light. The author determined the absolute threshold by interpolation of the plots of a number of contractions that were just perceptible, and finds that with a large field of retinal stimulation the pupillometric and visual thresholds coincide. It is interesting that at the threshold there is a scotoma at the macula and that the sensitivity curve for the activity of the pupil expressed as a function of the wavelength runs closely parallel to the scotopic luminosity curve. All these considerations constitute adequate proof that in the dark-adapted eye the pupillomotor threshold is determined by the retinal rods. A further tentative conclusion is of interest. It was found that temporal summation for the visual and pupillometric functions is the same, but that spatial integration is different; whereas the visual function is integrated spatially over small retinal areas, pupillomotor integration takes place over very large areas. From this the author concludes that the afferent fibres for pupillomotor activity are either collaterals from the retinal ganglion cells, the integration of which takes place centrally, or that a very small number of separate afferent fibres subserve pupillomotor activity in the optic nerve. Although not proved, this assumption is of considerable interest.

A shorter paper by Kleifeld, of Bonn, is of more than usual interest. It claims the existence of an intracapsular accommodative mechanism in the lens. It will be recalled that classical writers used to ascribe contractile properties to the lens fibres, properties conveyed by the name "musculus cristallinus". On electric stimulation of the lens the author records displacement of the fibres, a variation in their thickness, and a movement towards each other; this activity is most marked in the younger equatorial fibres and is associated with metabolic changes—a diminution of glucose and phosphates and an increased oxygen consumption. If it is confirmed that accommodative changes in the lens are not entirely the result of the passive displacement of its fibres during accommodation but are partly dependent on the active participation of the fibres themselves, the

standard views on the mechanism of accommodation will require alteration.

There is also an interesting paper by Best and Bohnen, of Bonn, on the disturbance of the electro-retinogram by movements of the lids and the eye; a very interesting description by Meyer-Schwickerath of the new clinical technique for sealing retinal holes by coagulation with light, a mechanism which can also be used for the destruction of retinal tumours and even for burning an artificial pupil in the iris; a detailed description by Leydhecker, of Bonn, of the clinical aspects of tonography; an extraordinary clinical experiment by Čavka, of Belgrade, on the transplantation of a cadaver lens (which remained transparent) into a blind human eye; and an interesting description by Müller, of Bonn, of the planning of the new Ophthalmic Clinic and Research Institute which has recently been opened in that University city.

STEWART DUKE-ELDER

BIOLOGY AND MEDICINE AT THE GENEVA CONFERENCE

Progress in Nuclear Energy

Series 6: Biological Sciences. Edited by J. C. Bugher, J. Coursaget and J. F. Loutit. Vol. 1. Pp. xi+205. 50*s*. net. Series 7: Medical Sciences. Edited by J. C. Bugher, J. Coursaget and J. F. Loutit. Vol. 1. Pp. xii+165. 42*s*. net. (London: Pergamon Press, Ltd., 1956.)

AT the Geneva Conference on the Peaceful Uses of Atomic Energy about one hundred papers were read in the sections on biology and medicine and a further two hundred were submitted but not read. All the papers submitted, together with the discussions at the meetings, were later published by the United Nations.

The purpose of the two volumes now under review was, according to the foreword, to bring together the significant matters of the sessions at Geneva in as compact a form as possible and to provide the reader with the essence of the discussions. This was a worthy aim, but it is only very partially realized, largely because of a lack of consistency in the method of approach of the various contributors. Some have given little but verbatim excerpts from the Conference papers, others have attempted a review of all the papers submitted in their section, while a third group have written general reviews of their particular subject with reference to the Conference papers where relevant. Thus these two volumes are a very mixed bag. There are certainly some excellent contributions, particularly in the volume on biological sciences, which includes a general review by Brues on radiation injury, by Scott Russell and others on the use of radioactive isotopes in agriculture and in the study of plant nutrition, by Bassham, Calvin and Porter on carbon-14 studies in plant biochemistry and by Comar and Wasserman on the use of radio-isotopes in the study of mineral metabolism. The chapter by Carter dealing with radiation and human genetics, although consisting largely of verbatim excerpts (including the complete transcript of Muller's paper), indicates clearly the difference in approach of the various schools to the problem of quantitative assessment of human genetic hazard.

The volume on medical sciences is less successful, since certain of the chapters consist largely of excerpts or pure summaries of a limited number of papers. It is difficult to see what advantage this offers since the reader may as well refer directly to the Conference papers. However, the reviews on the use of radio-active isotopes in medical diagnosis, by Belcher and Mayneord and by Ross, provide a very useful summary of the present position. The chapter by Binks on "Principles and Standards of Radiation Safety" gives a good account of the way in which this subject is being attacked in various countries.

The format and appearance of these volumes are good, but the lack of uniformity in the method of presenting references is a further indication of the inadequate editorial control.

These two volumes form part of a series on progress in nuclear energy to be issued annually. Since the present volumes deal so largely with the Geneva Conference it is not possible to foresee the future policy of the series with regard to form of review or the audience to which they are directed. It is hoped that it will be such as to satisfy a real need. There are already a number of annual reviews which include the subject of the applications of nuclear energy in medicine and biology, and there is a risk that too much effort can be diverted into writing reviews of essentially the same material.

L. F. LAMERTON

WATER POLLUTION

Aspects of River Pollution

By Dr. Louis Klein. With Chapters by Dr. J. R. Erichsen Jones and H. A. Hawkes. Pp. xii+621. (London: Butterworths Scientific Publications; New York: Academic Press, Inc., 1957.) 84*s*.; 14.50 dollars.

Disposal of Sewage and other Water-Borne Wastes

By Dr. Karl Imhoff, Dr. W. J. Müller and D. K. B. Thistlethwayte. (Based on a translation of "Taschenbuch der Stadtentwaessering". 16th edition. By Dr. Karl Imhoff.) Pp. x+347. (London: Butterworths Scientific Publications, 1956.) 45*s*.

Rural Water Supply and Sanitation

By Prof. Forrest B. Wright. Second edition. (Wiley Farm Series.) Pp. xvi+347. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1956.) 40*s*. net.

DR. KLEIN'S "Aspects of River Pollution" is an outstandingly good book, dealing in great detail with the wide field of work of a river board in controlling pollution in an industrial district. This involves a knowledge of the various methods of purifying sewage and trade wastes, of the legal aspects of the matter, of methods of examination of effluents and surface waters, and of the effects of polluting discharges on the chemistry and biology of rivers and their suitability for various purposes including domestic and industrial water supply. Dr. Klein, now the chief chemist of the Mersey River Board, has had a long acquaintance with all these aspects of pollution, and in writing his book has supplemented this experience with a most detailed and careful survey of the literature. His chapter on detection and measurement of pollution—more than one hundred pages in length—would have made a complete book in itself and is easily the best account of methods of chemical analysis in this field known to the reviewer.

The second book, "Disposal of Sewage and other Water-Borne Wastes", has had an unusual history, its first ancestor being a text written by Dr. Imhoff in 1906 for the guidance of the team, of which he was chief, which was preparing plans for the sewerage of the Essen district of Germany. Since then it has gone through many editions, in several languages, the present text being based on the sixteenth German edition of 1956. It gives an excellent and well-documented account of sewage treatment processes, and has two particular virtues—it deals equally thoroughly with German, British, and American practice, and it contains many worked examples of the calculations necessary in designing treatment plant. Indeed, the first English edition was published under the title "The Arithmetic of Sewage Treatment Works".

Both these books are concerned mainly with the treatment of urban wastes, whether domestic or industrial, and are addressed to the engineers, chemists, and biologists who as servants of industrial firms, of local authorities and river boards, or of Government, have to see that they are disposed of without nuisance. "Rural Water Supply and Sanitation", on the other hand, by the professor of agricultural engineering of Cornell University, is for the farmer or builder in a country district who may have to find his own water supply (the use of the divining rod is discouraged), dig his well, install the plumbing, and dispose of the resulting sewage by somewhat primitive methods. There are perhaps not many opportunities now in Britain for practising these arts but the book, which is well written and illustrated, should be very useful to the engineer going to work in an undeveloped territory overseas.

CONSEQUENCES OF SUCCESS

Some Observations on American Education

By Robert M. Hutchins. Pp. xiii+112. (Cambridge: At the University Press, 1956.) 15*s.* net.

MR. R. M. HUTCHINS has been the *enfant terrible* of higher education in the United States for twenty-five years. That is a long tenure for such an iconoclastic office. His latest book establishes anew his claim to the title. He writes with wit and sometimes with an acid pen: and he always has something interesting to say. "Some Observations on American Education" is based on lectures given three years ago in various British universities. It begins with a brief anatomy of the educational system of the United States; it then goes on to examine the ideals, standards, and organization of the system, with special reference to American universities; it has some entertaining things to say about alumni, athletics, and academic freedom; and it ends with some reflexions on the future of education in America.

The purpose of a controversial book is to arouse controversy. Mr. Hutchins's book (which is in this category) will doubtless achieve its purpose. However, there are canons of correctness even in controversy. Controversialists on serious topics should present all the relevant facts fairly and correctly, and concentrate their argument on interpretation of these facts. Mr. Hutchins has not done this. In the introduction he disingenuously says that he could have written quite a different and highly complimentary book about American education "and this approach would have required other illustrations". The book under review confines its illustrations to such items as the Department of Mortuary Science at Wayne University, Detroit, the advanced waiters' course in New York City Community College, California's B.Sc. in television, and the fact that basketball players in one university may "major" in elementary swimming, social dancing, and first aid. No one doubts the accuracy of these indictments; indeed Abraham Flexner[1] exposed them more than a quarter of a century ago, also in lectures given to a British audience. No one interested in American education would like to see such indictments suppressed, but if there is to be a reasoned and fruitful discussion over American education indictments need to be studied in perspective, not in isolation. This has recently been done for American higher education in two admirable books, one by Hofstadter and Hardy[2], and the other by Hofstadter and Metzger[3]. Anyone interested in Mr. Hutchins's thesis would do well to study these two books before reaching any conclusions.

As to the thesis itself, it is important and relevant to our own educational problems in Britain. America has adopted the doctrine of education for all: Is this consistent with the maintenance of high standards? Mr. Hutchins believes that the answer is "yes" but that all sorts of other factors have conspired to debase the currency of American education; so much so that in the minds of many Americans (so Mr. Hutchins suggests) education is a social device to accommodate the young and keep them amused until they are old enough to work. His message to his British audience, therefore, is: Follow our doctrine of education for all (a little gratuitous, perhaps, in view of the Education Act, 1944) but do not fall into the mistakes we have made in implementing the doctrine. He has evidence that the mistakes are due in part to the fact that there is so much money available for education in America: the mistakes are one of the consequences of success. That cause is not likely to operate in Britain. A deeper cause of the mistakes is that the American man-in-the-street demands the wrong results from education: he measures its efficacy in terms of financial and social success. This debilitating public opinion might not matter in Russia (where also there is education for all) but it does matter in America, and it would matter in Britain. So we should be grateful to Mr. Hutchins for one hint: that in a democracy public opinion can debase educational standards and has done so at some levels in America; and in Britain we would do well to educate the public more diligently than we have hitherto in the purpose of our educational system. But readers of Mr. Hutchins's book who observe a *non sequitur* between his indictments and the splendid achievements of American scholarship (not only in science and technology but also in history and archæology and even English literature) must not be surprised. Mr. Hutchins has exposed with wit and precision the seamy side of the American educational cloak. He asks us to agree with him that it is seamy; but we cannot pass judgment on a cloak until we have seen both sides.

ERIC ASHBY

[1] Flexner, "Universities: American, English, German" (Oxford Univ. Press, 1930).

[2] Hofstadter and Hardy, "The Development and Scope of Higher Education in the United States" (Columbia Univ. Press, 1952).

[3] Hofstadter and Metzger, "The Development of Academic Freedom in the United States" (Columbia Univ. Press, 1955).

Friction and Lubrication

By Dr. F. P. Bowden and D. Tabor. (Methuen's Monographs on Physical Subjects.) Pp. x+150+7 plates. (London: Methuen and Co., Ltd.; New York: John Wiley and Sons, Inc., 1956.) 10*s.* 6*d.* net.

A KNOWLEDGE of the effects of friction and lubrication is of great importance in the modern technological world and there has been a real need to have to hand a concise yet authoritative book so that the modern concepts of these subjects may be utilized and applied with confidence when considering practical problems. This need has been admirably filled by this monograph. The authors are to be congratulated on producing such a readable little book, and I would encourage anyone interested in frictional and associated phenomena to delve into its pages, and, if necessary, to use it as an introduction to the standard work by the same authors: "The Friction and Lubrication of Solids" (Oxford University Press, 1951).

After giving a historical introduction and reviewing the methods of measuring friction, the authors discuss the nature of solid surfaces and the true area of contact between them; they lead on to considerations of adhesion, the mechanism of friction using clean and contaminated metallic surfaces, the operation of polishing and rolling friction. Friction in non-metallic materials (including the development of the fast running ski) leads on to the subject of solid lubricants and to lubrication in general. After explaining the basic concepts of fluid lubrication, attention is directed to the theory and practice of boundary lubrication and to the work being done on extreme pressure lubrication.

Criticisms are few, but one does ask what parameter is represented by the abscissa in Fig. 5, and one would wish to see the index both accurate and enlarged—for example, the first mention of 'P.T.F.E.' is on p. 59 and not p. 57 and one must read p. 59 in order to discover that further consideration is given to this material on p. 66. DAVID TRAIN

Ion Exchange Technology

Edited by F. C. Nachod and Jack Schubert. Pp. x+660. (New York: Academic Press, Inc.; London: Academic Bocks, Ltd., 1956.) 15 dollars.

THE widespread use of ion-exchange processes on the industrial scale has resulted in a need for an authoritative text-book on the technology of the subject. "Ion Exchange Technology" is intended to meet this need and to serve both as a reference book and text-book for technologists and engineers. The fundamental aspects of ion-exchange are considered in the first part of the book, which includes chapters on the general properties of ion-exchange resins, equipment and process design, mass transfer and equilibria, deionization, electrochemical operations, ion-exclusion, economics and the prediction of fixed-bed performance.

In the second part of the book the applications of ion-exchange are described in chapters on water treatment, catalysis, metal recovery, the separation of rare earths, processing radioisotopes, the treatment of radioactive wastes, sugar refining, the purification of organic chemicals and on pharmaceutical and biological processes. The authors of the individual chapters are all experts in their respective fields and each chapter is useful and authoritative. Many of the chapters contain information which is not readily accessible or which has only recently been published. Short accounts of some important topics recur in several chapters. While this may be justified in the case of topics such as costs and stability, some unnecessary duplication could perhaps have been avoided and more detailed accounts of the mixed-bed process and the development of continuous ion-exchange processes included. Only a few minor errors have been noted and the general arrangement of the book is excellent.

The editors are to be congratulated on their initiative in arranging for the publication of this work, which is a valuable addition to the literature on ion-exchange. It should do much to stimulate still greater interest in the application of ion-exchange resins and ion-exchange processes.

D. K. HALE

The Theory of Functions of Real Variables

By Prof. Lawrence M. Graves. Second edition. (International Series in Pure and Applied Mathematics.) Pp. xii+375. (London: McGraw-Hill Publishing Company, 1956.) 56*s.* 6*d.*

THE first edition of this book appeared in 1946. It was noteworthy for a very careful discussion of the concept of a real variable, for precise and detailed analysis of the ideas of continuity and differentiability, and for its account of the Riemann, Lebesgue and Stieltjes integrals; the development of the Lebesgue integral was on lines suggested by F. Riesz, and a comparison may now be made with Riesz's own account in his book (written with Nagy) on "Functional Analysis". The expert may have found Graves's book a little lacking in outlook value, but the novice might be grateful for careful explanations and neat illustrations of difficult points. In the new edition, the main part of the book is substantially unchanged, but there are two new chapters, one on the theory of sets and transfinite numbers, the other a concise introduction to the notion of a metric space. Here again, explanations are lucid and precise, some exercises designed chiefly to enable the reader to test his assimilation of the text are supplied, and difficult points are illustrated with well-chosen examples. Thus, for example, three forms of Zermelo's axiom and three forms of Zorn's lemma are supplied, and the logical equivalences are worked out in full. References for further reading occur at the end of each chapter, and should do something to correct the one defect in an otherwise sound and valuable book, that it does not show sufficient resolution in breaking through into new ground; but the bases for further advance are thoroughly laid.

T. A. A. BROADBENT

Vibration Analysis Tables

By R. E. D. Bishop and Prof. D. C. Johnson. Pp. viii+59. (Cambridge: At the University Press, 1956.) 10*s.* 6*d.* net.

THE word 'receptance' has been adopted to stand for the amplitude of the motion at a chosen point of a dynamical system elicited by a simple-harmonic force of unit amplitude applied at the same or some other point. Thus a receptance is, in effect, a flexibility measured under the conditions of simple-harmonic motion; the name 'mechanical admittance' was formerly applied but abandoned because the analogy with electrical admittance is incomplete.

The numerical value of a receptance depends on the frequency and a matrix of the receptances provides a complete account of the behaviour of the system in simple-harmonic stimulation. Each element of the receptance matrix may be specified as a function of frequency or by numerical tabulation. The great value of receptances lies in the fact that the behaviour of a composite system can be very readily calculated when the receptances of its components are known and this applies, in particular, to the calculation of the natural frequencies.

The book under review is an advance publication of tables to be included in a text-book by the same authors. After some brief general explanations, tables of receptances are given for the following cases: lateral vibrations of cords, torsional oscillations of shafts, longitudinal oscillations of rods, flexural vibrations of thin uniform beams. Since very many systems can be built from these elements, together with masses and springs, it is clear that the tables will be of great service to those concerned with the analysis of oscillating mechanical systems.

W. J. Duncan

A Textbook of Plant Virus Diseases

By Dr. Kenneth M. Smith. Second edition. Pp. vii+652. (London: J. and A. Churchill, Ltd., 1957.) 65*s*.

THE second edition of this book is virtually a new text which describes the three hundred or so known plant viruses and the diseases they cause. The alphabetical arrangement of these is greatly to be appreciated, and a system of cross-references to synonyms also assists the reader. There will probably, however, be few who will read it from cover to cover, for the treatment is encyclopædic. The volume will be an indispensable guide to the research worker, advisory officer, teacher or commercial grower with the requisite technical training.

A description is given of the properties of each virus and of its transmission. Then follows a consideration of the diseases it causes, its host range and its geographical distribution. Symptoms are illustrated as far as practicable on 94 half-tone illustrations, and there are further diagrams showing the wide host range of some viruses. The range of viruses considered is world wide, and includes all those described at the present time. A few of the more recently found ones are given in an addendum. Even the six hundred pages of text do not contain all the minutiæ of present knowledge, and there is frequent reference to the bibliography which contains more than a thousand citations. An index of synonyms makes it possible to review quickly the whole range of viruses which attack a particular host. This is the most comprehensive book on plant virus diseases in the English language, and its up-to-date treatment should confer certain wider priorities until more new viruses are described.

John Grainger

The Myology of the Whooping Crane *Grus americana*

By Harvey I. Fisher and Donald C. Goodman. (Illinois Biological Monographs, Vol. 24, No. 2.) Pp. viii+127. (Urbana, Ill.: University of Illinois Press, 1955.) Cloth, 3.50 dollars; Paper, 2.50 dollars.

FOR more than twenty years the whooping crane has been on the verge of extinction, although a remnant of thirty to forty manages to hold its own as a result of vigilant protection. The present study was begun after two birds, which had unfortunately been shot during one month in 1952, became available for dissection, and it is an attempt to record the muscular anatomy of the species before the opportunity is, perhaps, lost for good. A third alcohol-preserved specimen was also dissected, in addition to material from related species.

Though there is a large literature on the comparative myology of birds, this is only the second species ever to receive complete treatment in a monograph, the other being the American raven, the subject of Shufeldt's classic study (1890). It is, of course, almost entirely a descriptive work, very competently executed, and illustrated by forty clear and detailed figures. The homology of bird muscles is full of difficult problems, and, though the authors have not made this their primary concern, they have paid close attention to innervation, and, by their carefully considered selection of names, have in fact made a very welcome and useful contribution towards clarifying the subject.

Two points of general interest are, first, the demonstration of considerable variations in anatomy, not only between different individuals but also between the two sides of the same subject (as in man); and second, the numbering of the digits in the bird's wing as 2, 3 and 4, in the tradition of Owen, and not 1, 2 and 3, as in practically all standard modern texts.

V. C. Wynne-Edwards

General Botany

By Prof. William T. Taylor and Prof. Richard J. Weber. Pp. viii+376. (Princeton, N.J.: D. Van Nostrand Company, Inc.; London: Macmillan and Co., Ltd., 1956.) 42*s*. net.

THIS new work is an excellent introductory text-book. The authors have obviously made every effort to present a modern account, and constantly stimulate the interest of the reader by striking examples illustrating the practical importance of the subject. Although the book is probably insufficient in itself to cover the syllabus of most Intermediate B.Sc. courses in botany, it could be read with profit by all students at that level, and seems particularly suited to meet the needs of medical and pharmacy students. The writing is clear and concise, but the American idiom is occasionally strange to the English reader.

The subject-matter is well chosen, on the whole, and errors are comparatively few. Some of the physiological sections, such as those dealing with respiration and photosynthesis, are outstandingly good, but tropisms and plant hormones merit a fuller treatment. More space is devoted to the cryptogams than is usual in a book of this type. There are a short account of viruses and an interesting chapter on bacteria. The algae and fungi are described in some detail, but there is no mention of flagellate algae. The book concludes with chapters on genetics and plant evolution.

There will probably be some difference of opinion as to the quality of the illustrations. These are bold and artistic and are described on the dust-cover as "unexcelled", but many teachers of botany will consider that some of the morphological figures are over-diagrammatic, and that accuracy has been sacrificed to obtain a false clarity. This one serious defect of the book could easily be rectified, however, during any practical work undertaken by the student.

A. Allsopp

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Sensitivity of Immature Mouse Sperm to the Mutagenic Effects of X-Rays

Dr. A. J. Bateman's careful analysis of X-ray-induced dominant lethality in the mouse[1] has yielded a sequence of mutation frequencies in successive matings which is strikingly similar to that of *Drosophila*, as established by me[2] and Khishin[3] for recessive lethals. In the mouse, as in *Drosophila*, successive matings of irradiated males result in an initial drop in frequency of mutation, followed by a pronounced peak, which in turn is followed by a decline to about the initial value and finally to a very much lower level. The initial drop, which in *Drosophila* takes place between the first and the second day, has been variously interpreted as due to a difference of sensitivity between fully mature and nearly mature spermatozoa[4,5] or as recovery from genetical X-ray damage during the first 24 hr. after irradiation[6,7]. Both interpretations are possible for the parallel drop in the mouse which, according to a personal communication by Dr. Bateman, is entirely due to an excess of dominant lethals on the first day.

A further analysis of the sensitivity pattern of the testis has been possible in *Drosophila*, where induced crossing-over and the formation of bunches of identical cross-overs can be used as markers for the treated stages[2] and where, moreover, irradiation of larvæ and pupæ allows a cytological check on the stage treated[8]. It has been inferred that maximal sensitivity occurs late in spermiogenesis, when spermatids become transformed into spermatozoa, that meiotic stages and young spermatids are about as sensitive as mature sperm, and spermatogonia much less so.

A similar analysis is not possible in the mouse, where crossing-over in the male occurs even without irradiation. One may, however, draw some conclusions on the stage treated from the time after irradiation at which aspermy or oligospermy occurs. A number of workers, most recently Oakberg[9], have shown that type *B* spermatogonia are by far the most easily destroyed stage, and that meiotic cells are much more resistant. With the low X-ray dose used by Dr. Bateman, spermatocytes are probably not killed—although their development may be somewhat delayed—and the oligospermic matings during the sixth and seventh week almost certainly represent irradiated late spermatogonia. The few dominant lethals which occurred during these weeks may have been due to admixture of spermatozoa treated during meiosis; there is also no reason for assuming that every dominant lethal which occurred in a spermatogonium must be eliminated in meiosis. On this interpretation, meiotic and early post-meiotic stages, sampled in weeks 4 and 5, are about as sensitive to the mutagenic effects of X-rays as mature spermatozoa, and the peak of mutation-frequency occurs at a late stage in spermiogenesis, as it does in *Drosophila*. At higher doses also spermatocytes are killed, and this—not killing of the very resistant spermatids[6]—explains why males given 500 r. became sterile already in the fourth week.

Dr. Bateman's interpretation of his findings is different. In his opinion, the sensitivity pattern to the mutagenic action of X-rays differs fundamentally between the mouse and *Drosophila*. There are two reasons for his belief. One is the assumption that in the mouse, as in *Drosophila*[2,9], spermatocytes are very easily destroyed by radiation: this results in an interpretation of the dominant lethal curve of the mouse which, in my opinion, is incorrect. The second is the assumption that in *Drosophila* "peak sensitivity [to mutagenic effects] is found in the most immature spermatids". This statement is in direct contradiction to the findings on recessive lethals quoted above. Presumably it is based on Dr. Bateman's own recent experiments with *Drosophila*[10]. In these experiments he measured dominant lethality by the percentage of non-hatching eggs and came to the conclusion that its incidence was highest in very early postmeiotic stages. But hatchability data which are not supported by cytological examination of the unhatched eggs are no unambiguous measure of rate of mutation and become utterly unreliable when the stage of oligospermy is approached. It is true that the X-ray dose to which Dr. Bateman exposed *Drosophila* males was too low to result in a stage of pronounced infertility; but it is probable that the very low hatchability on the ninth day after irradiation, which he interprets as entirely due to dominant lethality, was in fact partly caused by lack of sperm. It seems to me that Dr. Bateman's reasons for postulating a difference between the sensitivity patterns of mouse and *Drosophila* testis are not valid. It is true that, pending more precise information on the treated germ cell stages in the mouse, Dr. Bateman's data cannot be taken as definite proof that the sensitivity pattern is the same in both species; but even less can they be used as proof that the two patterns are different.

This question has a bearing on the assessment of radiation damage to the human testis. If Dr. Bateman's contention were correct, extrapolation would be impossible from *Drosophila* to man and very suspect from mouse to man. On the contrary, the observation that these two patterns show such a remarkable degree of parallelism suggests that we may be dealing with a fundamental property of male metazoon germ cells, and this may give us some confidence in extrapolations from animals to man.

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Jan. 10.

[1] Bateman, A. J., *Nature*, **178**, 1278 (1956).
[2] Auerbach, C., *Z.i.A.V.*, **86**, 113 (1954).
[3] Khishin, A. F. E., *Z.i.A.V.*, **87**, 97 (1955).
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[7] Nordback, K., and Auerbach, C., Brit. Emp. Cancer Camp. Report 395 (1955).
[8] Oakberg, E. F., *Radiation Res.*, **2**, 369 (1955).
[9] Friesen, H., *Biol. Zh.*, **6**, 1055 (1937).
[10] Bateman, J. A., *J. Genet.*, **54**, 400 (1956).

We consider that Dr. Bateman's timing of spermatogenic events in the mouse[1] requires discussion because of the impact it bears on the interpretation of radiation sensitivities. We believe that his estimate of six to seven weeks between spermatocytes and ejaculation, based on genetical evidence, shows a serious discrepancy with other estimates

based on non-genetical evidence. The following non-genetical evidence is taken from work on the seminiferous epithelium dealing with, first, the relative frequency of cell associations in normal males; secondly, these associations and their timing in irradiated males; thirdly, its labelling with radioactive tracers; and fourthly, the pattern of damage after various doses of radiation.

First, Roosen-Runge and Giesel[2] and Leblond and Clermont[3] accurately determined the relative durations of the spermatogenetic stages in the normal rat and mouse, based on the relative frequency of cell associations in the seminiferous epithelium, and both estimates agreed. Oakberg confirmed that, in general, spermatogenesis is very similar in both species[4]. Secondly, the relative durations in the rat can be therefore fitted without serious error to a total duration of the cycle equal to 34·5 days in mice; this figure was determined by Oakberg[5], using the methods of the former authors[2,3], from the rapid disappearance[4] of spermatogonia, the resulting depopulation, and the later repopulation, of cells in the seminiferous epithelium of mice irradiated with 100 r. Thus, the intervals obtained from the earliest spermatogonia *A* to the shedding of the spermatozoa in the testis are shown in Table 1, col. 1. It is possible that these figures are increased by delay due to irradiation.

Thirdly, work with radioadenine[6,7] and radiomethionine[8] injected at very low radiation doses into mature and immature male mice of several strains resulted in intervals of the same order as those obtained with the other procedures[2,5]. The initial labelling of deoxyribonucleic acid with adenine takes place only in spermatogonia[7], probably in spermatogonial generations other than the earliest. Labelled deoxyribonucleic acid is retained by the cells developing into spermatozoa, in which it is the main labelled component[6,7]. That labelling of deoxyribonucleic acid occurs only before meiosis is in accordance with other observations showing that deoxyribonucleic acid is not synthesized after that stage[9]. Methionine is taken up by spermatogonia and spermatocytes[8], so that a narrower interval can be timed than after labelling spermatogonia[7] with adenine. From these observations the approximate intervals from labelled spermatogonia to the first meiotic prophase is 5 days[7]; to early spermatids, 8 days[7]; to spermatozoa occurring free in the testis and epididymis, between 18 and 25 days[6–8]; and in the ejaculate, 28 days[6]. The last figure was obtained by interpolation between the ejaculation of unlabelled spermatozoa at 26 days and of labelled spermatozoa at 30 days[6]; but our recent unpublished work shows that ejaculated spermatozoa are still unlabelled at 28 days and that between 1 and 6 per cent of them are labelled at 30 days; the interval from labelled spermatogonia to ejaculated spermatozoa will therefore be taken as 30 days.

The last figure is most relevant in connexion with Dr. Bateman's estimate of six to seven weeks between spermatocytes and ejaculation, because on his estimate labelled spermatozoa should not be ejaculated until some time after 42 days. An increasing percentage of labelled spermatozoa for some days after 30 days[6] possibly corresponds with an increasing percentage of spermatogonia being labelled for some days after injection[7]. Assuming that the labelling took place in the last period of deoxyribonucleic acid synthesis just before meiosis[9], the addition of nine days (that is, the interval between earliest spermatogonia *A* and leptotene in Table 1, col. 1) to the tracer results gives the figures shown in col. 2; because of this assumption, the intervals between the earliest spermatogonia *A* and all later stages until ejaculation may be over-estimated. For a process such as spermatogenesis, the agreement in Table 1 between the calculations in col. 1 and the tracer results (col. 2) is reasonable.

Table 1. Approximate Intervals in Days from Spermatogonia to Later Spermatogenetic Stages in the Mouse (see text)

		(1)	(2)
Earliest spermatogonia *A* (second generation, ref. 3)		0	0
Spermatogonia *B*		4·7	
Resting spermatocytes		6	
First meiotic prophase	Leptotene	9	14
Early spermatids		20	17
Spermatozoa free in	testis	34·5	27–34
	epididymis		
Spermatozoa in ejaculation			39

The time taken for the transit of spermatozoa from their shedding in the testis to ejaculation can be assessed as follows. The above tracer data give intervals from certain stages to ejaculation: (*a*) from spermatozoa shed in the testis, 5–12 days (the dispersion being due to the fragmentary data); (*b*) from early spermatids, 22 days. By subtracting the interval of 14·5 days between early spermatids and shedding of spermatozoa in the testis (Table 1, col. 1), from interval (*b*), interval (*a*) is adjusted to 7·5 days. If, as mentioned before, the interval of 14·5 days includes delay due to irradiation, interval (*a*) may consequently be under-estimated here. Similar estimates for interval (*a*) were produced with different techniques by Hertwig[10] and other authors quoted in her paper.

Fourthly, from the above estimates, we can calculate which spermatogenetic stages would be affected by irradiation to initiate aspermia three weeks after 500 r. and oligospermia five weeks after 200 r. in Dr. Bateman's experiments[1]. For an interval of 7·5 days between shedding of spermatozoa in the testis and ejaculation, these stages (Leblond and Clermont's stages[3] fitted to a cycle of 34·5 days[5]; Table 1, col. 1) are: for 500 r. earliest spermatids, and for 200 r. resting spermatocytes. The stages affected agree to within one day with the most mature stages (meiosis and spermatogonia *B*, respectively) known from cytological evidence to be damaged in considerable numbers by these doses[4].

Thus, the results in Table 1, involving doses up to 100 r., provide estimates of about three weeks between early spermatids and ejaculation, and of about six weeks between the beginning of spermatogenesis and ejaculation, to be compared with Dr. Bateman's estimate of six to seven weeks between spermatocytes and ejaculation after 200 r. Furthermore, the above considerations relating to the cell damage[4] causing diminution in numbers of spermatozoa equally show that his estimate is excessive

Table 2. Approximate Stages of Spermatogenesis Sampled in Spermatozoa Ejaculated during Successive Weeks

Samples taken at centre of:	Stages of spermatogenesis sampled in spermatozoa
Week 1	Spermatozoa in vasa
,, 2	Latest spermatids
,, 3	Spermatids
,, 4	Meiotic prophase (pachytene)
,, 5	,, ,, (zygotene)
,, 6	Intermediate spermatogonia
End of week 6, etc.	Primordial spermatogonia

For renewal of primordial spermatogonia, see refs. 2, 4, 11.

after either 200 or 500 r. The approximate stages of spermatogenesis sampled in spermatozoa ejaculated after one to six weeks are shown in Table 2, which extends the calculations given above. With respect to Table 2, it must be emphasized, first, that this timing combines data from normal animals, and from animals irradiated up to 100 r.; second, that the timing of stages for the centre of weeks departs from the standard procedure in radiation genetics of scoring by full weeks after treatment.

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I should first like to congratulate Drs. Sirlin and Edwards on their excellent summary of the cytological data on the timing of spermatogenesis in the mouse. Of special relevance to my work with 200 r. is their reference to Oakberg's recent results after 100 r. There is still, however, a paucity of results on the time spent by the sperm on its journey through the epididymis and vas deferens, an interval which seems likely to be very easily modified by various factors, particularly by the pressure exerted from behind by further mature sperm leaving the seminiferous tubules. This would mean that destruction of the spermatogonia by irradiation would cause a sluggish passage through the epididymis four weeks later, when there was no sperm leaving the testis.

Nevertheless, the cumulative cytological evidence is such that it seems necessary to modify my original conclusions and assume that the sperm sampled during weeks four to seven had been irradiated as spermatocytes, not as spermatids. The peak in the third week would then after all be due, as claimed by Drs. Auerbach and Slizynski[1], to hypersensitivity of the spermatids. This is like *Drosophila*, though mouse spermatids show only twice the sensitivity of the sperm, whereas my estimate for *Drosophila*[2] shows a ratio of 10 : 1.

If the identification of the spermatogenic stages represented in the sperm sample of each week is taken as settled, the most important question becomes the origin of the dominant lethals from the irradiated spermatocytes, sampled in weeks four and five, and probably extending into weeks six and seven owing to the sluggish stream through the epididymis at this time.

My genetical timing of spermatogenesis[3] had been based on the *a priori* assumption that viable sperm carrying dominant lethals could not be produced from chromosome breakage in spermatocytes. One has to admit that there is no experimental evidence on this point. In *Drosophila*, where one might expect such evidence, the spermatocytes are alleged to be killed by irradiation[4], and in any event are of such short duration that their detection would be difficult in sperm samples.

It remains true, however, as observation of irradiated testes will show, that a high proportion of the products of meiosis immediately following irradiation are grossly abnormal, either as larger-than-usual pro-spermatids (restitution nuclei ?) or as misshapen and apparently impotent cells at later stages of spermiogenesis. Probably most of these abnormalities are accompanied by chromosome unbalance, so that many of the dominant lethals induced in spermatocytes cannot survive as effective sperm. If the dominant lethal incidence in matings of weeks four to seven is as high as in the first two weeks, the primary incidence must be higher. Thus spermatocytes must be mutagenically hypersensitive as well as spermatids. The quantitative estimation of their sensitivity can only be made with a type of mutation not subject to germinal elimination and obtained at a dose lower than 500 r., which sterilizes the spermatocytes.

The outcome of this very useful discussion seems to have been that what I at first regarded as a genetical method of timing spermatogenesis has turned out to be a method of studying mutation in spermatocytes.

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The Infra-red and the Bloch–Nordsieck Divergences

In recent years physicists have become so accustomed to divergences that the divergence of the number of emitted photons, which was found by Bloch and Nordsieck[1], is considered quite a normal state of things. The reason is that the total energy carried off by these photons and the transition probability remain finite.

However, I think that the appearance of an infinite quantity in a physical result is always unsatisfactory, and that it indicates that too rough a schematization of reality was made at some stage in the theory. In fact, in a previous paper[2], I have studied, in the Bloch–Nordsieck approximation, the number of photons emitted by an arbitrary classical system of charges, and I have shown that this number is always finite, provided the charges are confined within a finite region of space. Therefore, in every experiment which can actually be made, no divergence of the number of emitted photons appears, and the divergence found by Bloch and Nordsieck has its source in the particular problem studied (transition between two definite momentum states of an electron), which corresponds to an experiment that cannot really be made, because an infinite region of space is needed. This result may also be expressed in the following way. The energy per unit of frequency-range of the radiation emitted from a system

of charges of finite extension tends to zero as the frequency tends to zero, whereas the same quantity tends to a value different from zero in the case of the radiation emitted in the transition between two definite momentum states of an electron.

I have now extended the study to the emission of photons from an arbitrary quantum mechanical system. The purpose of this communication is to derive some of the most important results of this study in a very simple but (as I think) sufficiently rigorous way[3].

We consider here the emission of photons caused by the transition of the system from a given state to another state. In the Bloch–Nordsieck method, the problem is set out in two stages. First, the motion of the charges is studied neglecting the influence of the components of the electromagnetic field $A_\mu(x)$ which has an energy smaller than a fixed value. Then these components are deduced from the Maxwellian equation:

$$\Box A_\mu(x) = -j_\mu(x) \qquad (1)$$

where $j_\mu(x)$ is the current density calculated in the first stage. From this it follows, in the Bloch–Nordsieck approximation:

(1) The fact that a photon has been emitted in a given infinitesimal energy-range does not affect the probability of emission of a photon in another infinitesimal energy-range: in fact, an interaction between photons may only occur through their interaction with electrons, but we have assumed that the low-energy photons do not affect the electrons. Thus the probability W_N of the emission of N photons is given by the Poisson distribution, so that:

$$W_0 = \exp(-\overline{N}), \quad W_1 = \overline{N}\exp(-\overline{N}), \quad W_N = \frac{\overline{N}^N}{N!}\exp(-\overline{N}) \qquad (2)$$

where $\overline{N}$ is the average number of emitted photons.

(2) The average number $\overline{N}$ of the emitted low-energy photons is proportional to the square of the elementary charge e. (More exactly, e is here the coupling constant of the low-energy components of the electromagnetic field with the system of charges. In the Bloch–Nordsieck approximation these components are entirely separated from the high-energy components.) In fact, the operator corresponding to the number of photons is a bilinear expression with respect to $A_\mu(x)$. Now, $A_\mu(x)$ is a solution of equation (1), so that it is proportional to e, since $j_\mu(x)$ is proportional to e. Hence $\overline{N}$ is proportional to e^2.

Now expand W_1 in powers of e. Then from (1) and (2) it follows that the first term $W_1^{(1)}$ of the development (which is of the order of e^2) is:

$$W_1^{(1)} = \overline{N} \qquad (3)$$

Thus we have the following important result. In the Bloch–Nordsieck approximation the average number of photons emitted in a transition is equal to the first term of the expansion in powers of e of the emission probability of one photon in the same transition.

This result provides a very simple general method for calculating or studying $\overline{N}$. In particular, we can deduce the following from it:

(*a*) The infra-red divergence (divergence in the perturbation calculation of the emission probability of a finite number of photons) and the Bloch–Nordsieck divergence are the consequence of the divergence of the same expression, although they have an entirely different physical meaning.

(*b*) Consider the transition of a quantum mechanical electron from a given state of definite momentum to another one. In this case the first-order perturbation calculation of the probability of emission of one low-energy photon[4] leads to the same formula as that which Thirring and Touscheck[5] have deduced for the average number of photons emitted in the analogous classical problem. Then from formula (3) it follows that the average number of photons emitted in the quantum mechanical problem is the same as in the corresponding classical problem, and Thirring and Touscheck's formula holds also in the quantum mechanical case[6].

(*c*) Consider now a transition between two bound states. In this case it is known that the first-order perturbation calculation of the probability of emission of one low-energy photon leads to a finite result. Then from formula (3) it follows that in such a transition even the number of photons emitted remains finite. This is also true if the initial and final states are not bound stationary states but superpositions of such states. This result is the extension to the quantum mechanical case of the result which I have already obtained in the classical case[2].

If we assume, as it is reasonable, that in every real experiment the initial and final states are of the kind considered in (*c*), then we can affirm that in every real experiment the number of the emitted photons is finite.

The significance of this result may be better understood by an example. Consider a scattering experiment: an electron, initially at rest, for example, in a metal wire in the laboratory, is accelerated by a machine up to an energy E; then it hits a target, and finally comes to rest in this target. The usual way of schematizing such an experiment is to say that the electron has undergone a transition from a state of definite energy E to a state of energy 0 (in the laboratory system). With this schematization one finds that an infinite number of photons is emitted. However, it is clear at once that such a schematization is appropriate if we consider the emission of photons of sufficiently small wave-length, but it is quite wrong if we consider the emission of photons of wave-length greater than the size of the laboratory. In the latter case the correct schematization is to say that the initial and final states are two bound states, in the first of which the electron was bound to the metal wire, in the second one to the target. With this schematization the number of emitted photons remains finite.

These results confirm the suggestion that in every case the Bloch–Nordsieck divergence is only the consequence of too rough a schematization of reality.

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Electron Microscopy of Vulcanized Rubber using Gelatine First-Stage Replicas

Two-stage replication techniques using evaporated carbon as the second stage have been widely applied in the electron microscopy of solid surfaces[1]. The most popular materials for first-stage replicas, however, are soluble only in organic liquids, and since vulcanized rubber generally swells in contact with such solvents, they must be avoided if faithful reproduction of such a surface is to be obtained.

Water-soluble polymers have been employed for the replication of rubber by several workers. Harris[2] used a solution of gum arabic and glycerol, and gelatine has been used by Bromley and Downer (private communication). We have examined a number of other water-soluble materials. Ammonium polymethacrylate and polyvinyl alcohol have inferior film-forming properties, and sodium alginate films, though desirable in several ways, swell in water to such an extent that the evaporated carbon layer is severely disrupted. The present communication is concerned with the use of gelatine in the first stage of the replication process.

In the technique employed by Bromley and Downer, a 20 per cent solution of gelatine in water at 80° C. was cast on the freshly created rubber surface and allowed to dry. The gelatine wafer was stripped and a layer of carbon evaporated on to it, after which the gelatine was dissolved away by floating on warm water. While we occasionally obtained good micrographs by this method, the resolution, though passable, generally fell below the standard required in our investigation. The inconsistency was eventually traced to the persistence of a thin layer of gelatine, a few hundred angstroms thick, in contact with the carbon film. Prolonged washing in water or alkali failed to disperse the layer, even in samples which had not been exposed to the electron beam. Fig. 1 shows the edge of a replica at which the carbon film has folded back from the gelatine layer. (The dark circles are carbon-black filler particles extracted from the surface of the rubber.)

Acting upon a suggestion from Mr. A. G. Ward, enzymatic destruction of the gelatine was attempted, with complete success. The gelatine – carbon sandwich is floated in a saturated solution of trypsin in 0·1 *M* sodium chloride. The temperature, as is to

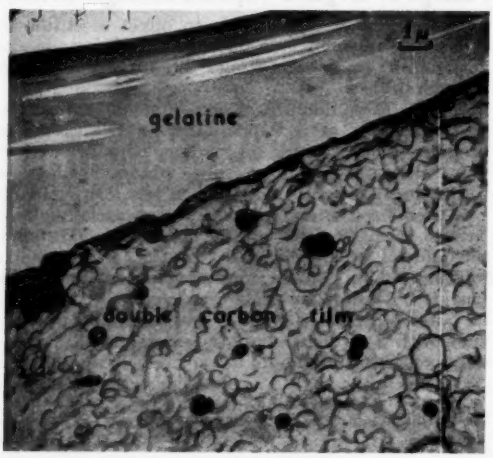

Fig. 1

Fig. 2

be expected, is quite critical, and must be kept at 37°–39° C. Under these conditions the carbon film, in most cases wholly intact, is separated from the gelatine in 15–20 min.; this time could be even further reduced if trouble were taken to adjust the *p*H to 8, though in practice this would necessitate the use of a buffer solution. The end-point of the digestion process is indicated by disappearance of the 'streamers', visible in strong light below the dissolving gelatine wafer. The carbon film is lifted on a glass slide and refloated in distilled water, being allowed to wash there for five to ten minutes before collection on a copper grid.

An example of the results obtained is given in Fig. 2, which shows the torn surface of a vulcanized natural rubber containing 33 per cent by weight of colloidal carbon black. The replica, which has been shadowed with a small quantity of gold–palladium, probably has a resolution of better than 100 A.

This work, which will be fully reported elsewhere, forms part of a programme of research undertaken by the Board of the British Rubber Producers' Research Association, in conjunction with the Department of Applied Physics of Northampton Polytechnic.

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A Method of investigating the Stress-Distribution in Granular Materials

The problem of the direct determination of the distribution of stress in a mass of granular material, under a specified system of loads, is of considerable practical importance in such fields as powder metallurgy and soil mechanics. In the solution of such problems, however, many difficulties are encountered, and in the present communication a simple technique, believed to be original, is presented.

In the study of the stress-distribution in a granular material the technique in which the whole of the

granular mass is represented by a solid block of photo-elastic material, suitably shaped and loaded, has previously been used, the stresses being determined by the conventional methods of photo-elastic analysis. Such a technique is of very doubtful validity, since in an unbonded mass of granular material relative motion between the individual particles could well affect the distribution of stress and invalidate the laws of elasticity.

In an effort to meet these objections, we have simulated a mass of granular material by the use of a number of rollers made of a stress-optically active material, the rollers being arranged with their axes parallel and parallel to the optical axis of the bench. While loaded, the model was examined by the use of circularly polarized light, and the stress deduced from the relative brightness of the rollers. The objection to this model is that, if an apparatus of moderate size is to be used, rollers of diameter sufficiently small to simulate correctly the particles in a granular material cannot be obtained; furthermore, the number of rollers required is prohibitive.

In the model now proposed, the granular mass is simulated by the use of a powdered material. At suitable co-ordinate points in the mass, indicators made of a stress-optically active material of a length sufficient to extend throughout the whole depth of the model are inserted. The directions of the principal stresses in these indicators are determined by the rotation of the polarizer and analyser of the optical bench; the angular positions of the crossed polarizer and analyser, for extinction, giving these directions.

If these directions, at each co-ordinate point, are inserted on a suitable diagram, and provided that the directions of the stresses in the indicators are the same as those which would be present if the indicator were replaced by granular material, then a diagram showing the directions of the principal stresses in the granular mass may be drawn. Thus a two-dimensional model, in which all the significant characteristics of a granular material would be expected to be operative, is obtained.

As an example of the application of the technique to a practical problem are shown the results of experiments on a model simulating the distribution of stress in a granular material in a tube under plungers of various diameters.

The apparatus shown in Fig. 1 consists of a U-shaped brass plate $\frac{1}{4}$ in. thick, on each side of which is clamped a sheet of 'Perspex', also $\frac{1}{4}$ in. thick. In the slot so formed slides a plunger for the application

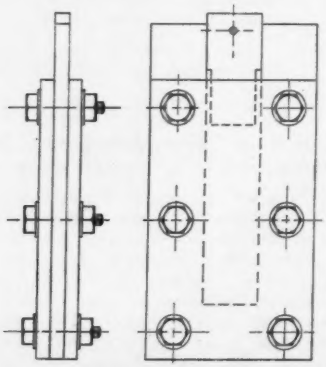
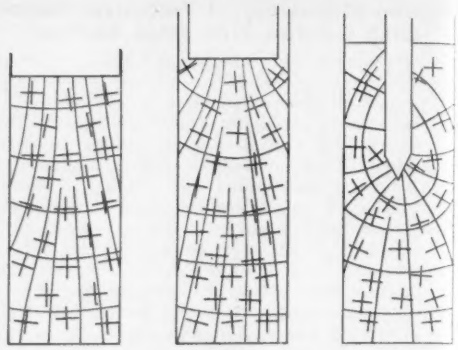


Fig. 1



(a) (b) (c)

Fig. 2

of the load. The granular material together with the photo-elastic indicators, which are 'Perspex' cylinders $\frac{5}{32}$ in. diameter, are loaded into the cavity under the plunger.

In Fig. 2 are shown the stress-distributions as obtained by this method; in Fig. 2*a* is shown that under a plunger the same diameter as that of the tube, in Fig. 2*b* that under a plunger of diameter 0·8 of that of the tube, and in Fig. 2*c* that under a plunger of diameter 0·25 of that of the tube.

It is interesting to note that in the latter case the stress pattern begins to show features normally associated with the stress-distribution around a pile even though, in the present case, considerable wall-effect is operative.

While we do not consider the method to be free from objections, it is felt that it may prove to be a valuable tool and may be of interest to workers in allied fields.

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Passage of Organic Vapours through Orifices

The object of this note is to direct attention to a peculiar phenomenon discovered during an investigation on the passage of organic vapours through orifices.

In one of a number of experiments, *para*-nitrophenol vapour at a temperature of 130° C. and a pressure of 0·02 mm. of mercury was allowed to flow along a capillary tube (internal diameter 0·61 mm., length 10 cm.), into a chamber where it was condensed on an ice-cooled brass surface placed 3 mm. from the end of the capillary. The *para*-nitrophenol was deposited on the surface in a diffraction-like pattern consisting of a central disk (radius 0·2 mm.), an inner ring (radius 1 mm.) and an outer ring (radius 4 mm.). It has also been found[1] that with a straight slit, two symmetrically placed deposits with a minimum at the centre are produced.

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Competition in Atomic Halogenation Reactions

It has been shown recently[1] that it is useful to consider a general mechanism for atomic halogenation reactions, which, in the case of the photochlorination of C_2Cl_4 and C_2HCl_3, is given by :

$$Cl_2 \xrightarrow{h\nu} 2Cl \quad (1)$$

$$Cl + C_2Cl_4 \rightarrow C_2Cl_5 \quad (2) \qquad Cl + C_2Cl_3H \rightarrow C_2Cl_5 + HCl \quad (2')$$

$$C_2Cl_5 + Cl_2 \longrightarrow C_2Cl_6 + Cl \quad (3)$$

$$C_2Cl_5 \rightarrow Cl + C_2Cl_4 \quad (4) \qquad C_2Cl_5 + HCl \rightarrow Cl + C_2Cl_3H \quad (4')$$

$$C_2Cl_5 + Cl \longrightarrow C_2Cl_5 + Cl_2 \quad (5)$$

$$2Cl + M \longrightarrow Cl_2 + M \quad (6)$$

$$Cl + C_2Cl_5 \longrightarrow C_2Cl_6 \quad (7)$$

$$C_2Cl_5 + C_2Cl_5 \longrightarrow C_2Cl_6 + C_2Cl_4 \text{ (or } C_4Cl_{10}) \quad (8)$$

It has also been shown that the usual steady-state treatment is adequate for calculating overall rate equations[2], and that absolute reaction-rate theory and rough estimates of activation energies and entropies permit one to calculate approximately the overall rate constants[1].

The rate of substitution (*D*1, Table 1) and of several competition reactions (*A*2, *E*, *F*, *G*) have now been measured[3] and are summarized in the table with the previously measured rates of addition (*A*1, *B*) and of dehydrochlorination (*C*)[1]. Table 1 shows further that several overall rate constants which are measured directly may equally well be calculated from other measurements. The good agreement between these direct and indirect determinations is an extremely satisfactory control of the accuracy of the proposed mechanism; it shows further that the error limits for activation energies and frequency factors are extremely narrow.

Further, as shown in Table 1, the life-time of the reaction chain in the addition reaction at low temperature (*H*) yields values of three rate constants of elementary steps (*H*, *I*, *J*).

We intend to measure further the life-time of the reaction chain of the addition reaction at high temperature and of the dehydrochlorination, as well as further competition reactions, and to calculate the equilibrium constants. This should yield values for the eight rate constants which determine the reaction mechanism. A discussion of the measured values of activation energies and entropies in terms of reaction-rate theory will be useful after several similar systems have been studied ($C_2HCl_3 - C_2H_2Cl_4$; $C_2H_2Cl_2 - C_2H_3Cl_3$; etc.).

The Institut pour la Recherche Scientifique dans l'Industrie et l'Agriculture and the Fonds National de la Recherche Scientifique (Brussels) are thanked for their assistance.

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Gas-Chromatographic Analysis of Higher Fatty Acids; up to and including Cerotic Acid

The rapid gas-chromatographic analysis of fatty acid methyl esters was applied by Cropper and Heywood[1] and by Dijkstra, Keppler and Schols[2] to the saturated fatty acids up to and including behenic acid. James and Martin[3] and James and Wheatley[4] analysed unsaturated and saturated fatty acid methyl esters up to and including a C_{18}-acid.

Table 1. Correlation between the Rate Constants of Chlorination and Dehydrochlorination of C_2Cl_4 and C_2Cl_3H and of Competition between these Reactions

Type of rate measurement or combination of measurements	Rate equation	Temperature interval	Value of log (rate constants representing directly measured rates)	Value of log (rate constants giving best agreement between directly measured and calculated rate constants)
A. (1) addition at low temperature $Cl_2 + C_2Cl_4$	$(I_a^{1/2}k_2/k_3^{1/2})(Cl_2)^{3/2}$	360°–430° K.		
(2) reaction of Cl_2 with a mixture $C_2Cl_4 + C_2Cl_3H$		370°–390° K.	$-\ 660/T + 2{\cdot}56$	$-\ 660/T + 2{\cdot}56$
(3) from substitution (*D*1)		370°–430° K.		
B. addition at high temperature	$I_a^{1/2}\,k_2(k_3/k_4k_7)^{1/2}(Cl_2)(C_2Cl_4)^{1/2}$	520°–560° K.	$+ 1{,}800/T - 1{\cdot}17$	$+ 1{,}725/T - 1{\cdot}20$
C. dehydrochlorination	$(I_a k_2'k_4/k_7)^{1/2}\,(C_2Cl_4H)^{1/2}$	400°–470° K.	$-\ 2{,}500/T + 6{\cdot}20$	$-\ 2{,}450/T + 6{\cdot}20$
D. (1) $(k_2k_3/k_7)^{1/2}$ {from substitution / *B*.E.$^{1/2}$} (2)	$I_a^{1/2}(k_2k_3(Cl_2)/k_2'(C_2Cl_3H)+k_3)^{-1/2}k_3(Cl_2)$	370°–430° K.	$-\ 800/T + 3{\cdot}12$	$-\ 675/T + 3{\cdot}05$
E. (1) from equality of addition and dehydrochlorination	$k_3k_2'(C_2Cl_3H) = k_2k_3(C_2Cl_4)(Cl_2)$	400°–430° K.	$-\ 4{,}600/T + 8{\cdot}46$	$-\ 4{,}800/T + 8{\cdot}50$
(2) (*D*/*B*)^2				
F. (1) competition substitution—dehydrochlorination	$k_4/k_3(Cl_2)$	400°–430° K.	$-\ 2{,}890/T + 4{\cdot}98$	$-\ 3{,}550/T + 6{\cdot}30$
(2) (*C*/*D*)^2				
G. (1) competition addition substitution	$k_2(C_2Cl_4)/k_2'\,(C_2Cl_3H)$	365°–385° K.	$+ 1{,}400/T - 2{\cdot}28$	$+ 1{,}250/T - 2{\cdot}20$
(2) (*B*.*C*/*D*^{2})^2				
(3) (*C*/*B*.*E*)^2				
(4) *F*/*E*				
H. $Cl_2 + C_2Cl_4$ at low temperature in intermittent light	$k_3^{1/2}$	360°–420° K.	$-\ 150/T + 4{\cdot}6$	$-\ 150/T + 4{\cdot}6$
I. *A*.*H*.	k_2			$-\ 810/T + 7{\cdot}2$
J. *I*.*F*.	k_4			$-\ 4{,}360/T + 13{\cdot}5$

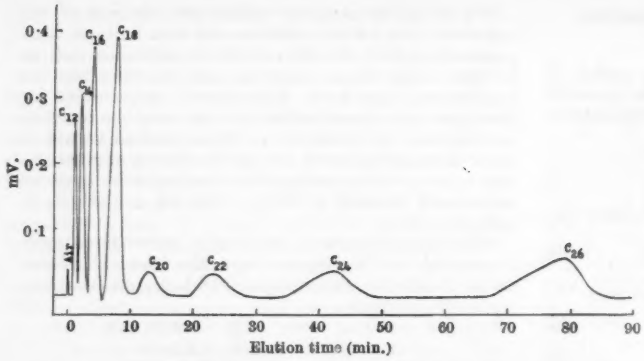

Fig. 1. Separation of 13·2 mgm. methyl esters of the even-numbered fatty acids C_{12}–C_{26} (inclusive). Column length, 113 cm.; diam., 0·4 cm. Immobile phase, 20 parts silicone oil on 'Celite 545' (300–600μ); temperature, 257° C. ('Dow-Therm *A*'); nitrogen pressure, 30 cm. mercury; rate of flow of nitrogen, 24 ml./min.; composition of the mixture: 4·8 per cent C_{12}; 8·2 per cent C_{14}; 16·8 per cent C_{16}; 22·5 per cent C_{18}; 3·4 per cent C_{20}; 5·6 per cent C_{22}; 9·7 per cent C_{24}; 29 per cent C_{26}

By employing the gas-density meter of Martin and James[5], we succeeded in analysing the even-numbered saturated fatty acid methyl esters from C_{12} to C_{26} (inclusive) in about 90 min. (Fig. 1). In the analysis, 'Celite 545', screened to particle size 300–600 μ, was employed as carrier.

The following immobile phases can be used at the temperature (257° C.) at which the analysis is carried out: 'Apiezon *L*', silicone oil 'Dow Corning', silicone grease (Edwards) and 'Polythene alkathene', grade 2 (I.C.I.).

Fig. 2 shows the analytical results obtained on applying this method to the methyl esters of higher fatty acids occurring in an arachidonic acid concentrate (I) prepared from adrenals. A marked difference is observed in the elution times of saturated and unsaturated C_{20}-acids. From an analysis of the same, but brominated, esters from (I) on the above-mentioned column it appeared that the concentrate consisted practically entirely of unsaturated fatty acids.

Recent experiments, employing a newly designed katharometer, which can easily withstand temperatures up to 350° C., showed that this apparatus is also eminently suitable for the analysis of the higher fatty acid methyl esters.

More detailed information on this subject will be published in due course. We wish to thank the management of Unilever N.V., Rotterdam, for permission to publish these findings.

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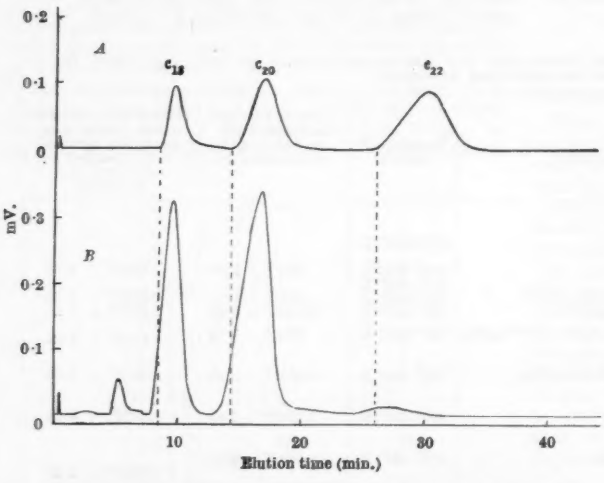

Fig. 2. Nitrogen pressure, 26 cm. mercury; rate of flow of nitrogen, 19 ml./min. The other experimental conditions were the same as those mentioned under Fig. 1. Curve *A*, separation of 6·3 mgm. methyl esters of the saturated fatty acids C_{18}, C_{20} and C_{22}; curve *B*, separation of about 14 mgm. methyl esters of the higher fatty acids occurring in an arachidonic acid concentrate obtained from adrenals

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Evidence of Regularities in the Chemical Structure of α-Keratins

Studies of the low-angle X-ray diffraction patterns of various α-keratins by Corey and Wyckoff[1], MacArthur[2] and Bear and Rugo[3] have established the presence of structural regularities with minimum repeat distances of the order of 200 A. parallel to the fibre axis and 90 A. perpendicular to this axis. Evidence of chemical reactivity associated with the lateral periodicity was obtained by Zahn and Kohler[4], who noted the appearance of intense low-angle equatorial reflexions in human hair after treatment with nitric acid, these being further modified by heating in a solution of copper acetate. We wish to report new evidence of regularities in the chemical structure of α-keratins obtained by studying the X-ray diagram of Lincoln wool after reaction with various atoms and ions of high atomic number.

Richards and Speakman[5] have shown that a specific conversion of the tyrosine residues in wool to 3 : 5 di-iodotyrosine can be achieved by reaction with a solution of iodine in ethanol, the loosely bound iodine afterwards being removed with sodium thiosulphate, and a sample of wool was treated in this way. In general, the X-ray diffraction photograph was very poor due to high absorption of the X-ray beam, but two very prominent reflexions were observed on the meridian at 24·8 A. and 34 A., the latter showing fine structure and not appearing in untreated wool. A similar photograph was

obtained when the loosely bound iodine was not removed, the only difference being an increased absorption of the X-ray beam. The prominent meridional reflexions indicate a regularly repeating pattern of tyrosine residues in the crystalline regions at intervals of 25 A. and 34 A. in the direction of the fibre axis.

Osmium tetroxide has been used extensively in electron microscopy to study fine structural detail in biological materials, and we have also found it of value in X-ray studies. Lincoln wool was immersed in a 2 per cent solution of osmium tetroxide for 24 hr. and afterwards washed in distilled water for a further 24 hr. The X-ray diffraction pattern showed marked changes in the low-angle equatorial reflexions, those at 27 A. and 45 A. being greatly intensified, and in addition a reflexion at 39 A., previously observed only in African porcupine quill[2], appeared on the meridian. The high-angle reflexions were weaker and slightly more diffuse in appearance, presumably due to a general increase in absorption within the specimen. Cross-sections examined in the optical microscope showed an apparently uniform deposition of osmium throughout the structure.

Treatment with 1 per cent solutions of barium acetate, phosphotungstic acid, cupric acetate and silver nitrate, led to considerable deposition within the fibre, as evidenced by the high absorption of the X-ray beam, without any specific effect on the diagram. In contrast, treatment with 1 per cent mercuric acetate in 1 per cent acetic acid yielded a wealth of new detail. The 27 A. and 45 A. equatorial reflexions were greatly intensified, and a reflexion at 16·8 A., which is weak in untreated wool and has not previously been reported, was also intensified slightly. In addition, a new equatorial reflexion appeared at 12·5 A. corresponding to the seventh order of an 85 A. repeat, and the seventh, twelfth, sixteenth and nineteenth orders of the 198 A. axial repeat were sharpened and slightly intensified (see Table 1). In this instance interpretation is hampered by the fact that mercury is probably bound to a variety of residues in the structure[6].

Detailed interpretation of the intensity changes and new reflexions resulting from the treatments described here must await further study, but already certain general conclusions can be drawn. It is clear that wool keratin can bind appreciable quantities of heavy-metal ions without significant effects on the X-ray diffraction diagram. This recalls the studies of Astbury and Dawson[7], where a similar result was obtained with dye uptake. In both cases it appears that binding is confined to the non-crystalline regions of the fibre. In the case of mercuric acetate, however, where the X-ray diagram is considerably modified, we have clear evidence of a regular three-dimensional distribution of chemical reactivity in the crystallites.

The maximum spacing which could be resolved with the X-ray diffraction camera used in these experiments was about 50 A., and a camera of considerably greater resolving power is now being used to measure the spacings reported in Table 1 with greater precision and to record additional reflexions at lower angles.

Table 1. Intensification (+) of Reflexions in the X-Ray Diffraction Pattern of Lincoln Wool Fibres after Chemical Modifications

Meridional reflexions

Order of 198 A.	Untreated wool spacing (A.)	Osmium-treated	Iodine-treated	Mercury-treated
5	–	+ (39 A.)	–	–
6	–	–	+ (34 A.)	–
7	28·5	–	–	+
8	24·8	–	+	–
10	19·8	–	–	–
12	15·8	–	–	+
16	12·7	–	–	+
19	10·4	–	–	+

Equatorial reflexions

Order of 85 A.	Untreated wool spacing (A.)	Osmium-treated	Iodine-treated	Mercury-treated
2	45	+	–	+
3	27	+	–	+
5	16·8	+	–	+
7	–	–	–	+ (12·5 A.)

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Oxidation and Decarboxylation of Citrate in the Presence of Ferrous Iron

Although a paper by Wieland and Franke in 1928[1] described the induced oxidation of several hydroxy-acids in the presence of oxidizing ferrous iron, citric acid was not specifically mentioned, and its reaction under these conditions appears not to be well known. We have observed that mixtures of sodium citrate and ferrous sulphate, shaken in air at 28° C. and *p*H 6·0, absorbed oxygen in excess of that required to oxidize the iron. At the same time carbon dioxide was evolved, and the quantities of carbon dioxide evolved and of excess oxygen absorbed were approximately equimolar. The amounts of excess oxygen (presumably consumed in the oxidation of the citrate), and of carbon dioxide, were proportional to the initial amount of ferrous iron. No reaction was observed in the absence of oxygen. The identification of the decomposition products of citrate, apart from carbon dioxide, was not attempted.

In the reaction with citrate, the ferrous ion could be replaced by stannous ion (which is also readily oxidized by air), but not by ferric, manganous, mercurous, zinc or silver ions. In addition to citrate, the following organic anions were examined in mixtures with ferrous iron, with results as indicated:

Oxalate: slight excess of oxygen absorbed.
Succinate, phthalate and ethylenediamine tetraacetate: excess oxygen absorbed and small amounts of carbon dioxide evolved.
Tartrate: marked oxidation and decarboxylation.

The reactions observed are purely chemical, but they may have significance in biological systems. In the presence of oxygen, the ferrous iron in complexes with citrate and other anions would soon become oxidized and its effect nullified. If, however, another system existed to regenerate the ferrous form, con-

siderable quantities of citrate, tartrate, etc., could be decomposed under physiological conditions.

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Effects of Massive Iron Overload in the Rat

The low toxicity of iron–dextran complex ('Imferon') has made it possible to follow for the past eighteen months the effects of administering intramuscularly a total dose of 1,650 mgm. iron per kgm. to rats. Control animals on the same diet (M.R.C. diet 41 containing 1 per cent of cod liver oil) over the same time were treated with equivalent amounts of dextran, without iron.

The iron-loaded rats have remained in good health, though the growth-rate of male animals in particular has been below that of the dextran controls. At intervals, groups of rats have been killed: the dextran-treated controls showed no abnormality; in the others there was organ siderosis but nothing to suggest the development of hæmochromatosis[1]. On the contrary, the only changes noted to date in the iron-treated animals are effects which form part of the characteristic picture of vitamin E deficiency in the rat: rapid post-mortem renal autolysis[2,3] (from 9 weeks onward), brown uterus[4] (from 50 weeks onwards) and testicular atrophy[5] (only in two instances, at 47 and 52 weeks). The most striking feature in all the animals was the massive accumulation of ceroid-like pigments, particularly in the kidney (Fig. 1). A direct comparison with the organs of a rat deprived of vitamin E for 651 days was made possible through the kindness of Dr. T. Moore. A close similarity exists, with minor differences in the staining reactions and distribution of the ceroid pigments. It should be emphasized that none of these changes was present in control rats treated with dextran only.

In the vitamin E-deficient rat, renal autolysis is accompanied by an increase in tissue non-protein nitrogen[3]. This observation could not be repeated in the iron-loaded rats, where no significantly greater increase was observed than that obtained for normal rat kidneys under the same conditions; nor did the iron-loaded rat kidneys have a higher Q_{O_2}. Despite careful and repeated examination, no evidence has been found of the existence of some of the most important characteristics of vitamin E deficiency in the rat: muscles, nervous and adipose tissues, as well as incisor teeth were all normal; the dialuric acid hæmolysis test was negative and no excessive creatinuria, phosphaturia or amino-aciduria could be detected. The absence of these manifestations of vitamin E deficiency suggests that, if such a state of deprivation is present in the iron-loaded rats, it is localized in susceptible tissues.

Tappel[6] has given quantitative expression to the catalytic function of hæmoglobin, hæmin and cytochrome *c* in copolymer formation from unsaturated fats and proteins. We have produced a similar

Fig. 1

ceroid-like polymer *in vitro* by using ferritin. In many of its characteristics it resembles the ceroid present in the iron-loaded rats, and differs distinctly from the ceroid which can be made *in vitro* by the catalytic action of hæmoglobin. It would appear likely that high concentrations of intracellular iron, either as ferritin or hæmosiderin, are capable of exercising hitherto unsuspected effects. These may perhaps provide an explanation for some of the pathological concomitants of Bantu siderosis.

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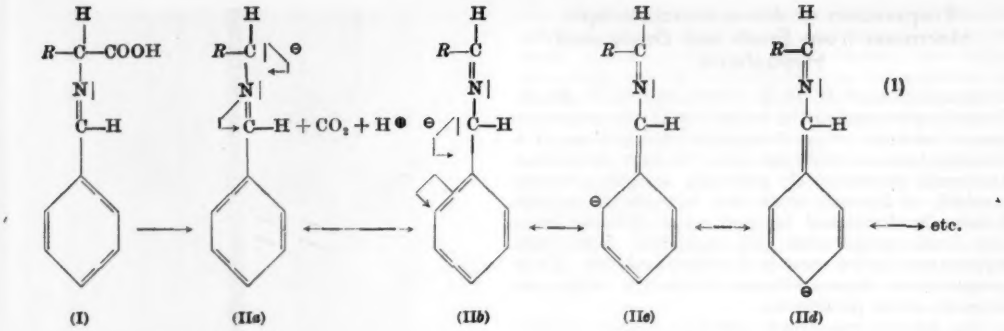
Catalytic Decarboxylation of α-Amino-Acids

Non-enzymatic decarboxylation of α-amino-acids was tried many years ago by heating them above 200° C., often dissolved or dispersed in an inert solvent too. As the reactions are always exotherm, heating is only required to reach the rather high energies of activation. The way in which Nature lowers these energies by enzymatic reactions has been frequently discussed. The formation of a Schiff's base between an α-amino-acid and pyridoxal-phosphate as the proved prosthetic group of most of the decarboxylases is postulated by many authors, and the easiness of their decarboxylation may be understood with the help of the electronic theory of valence.



Also in non-enzymatic decarboxylation of α-amino-acids aromatic aldehydes can act as catalysts. In 1886, Curtius and Lederer[1] obtained decarboxylation by heating a mixture of glycine and benzaldehyde up to 130° C. But the end-product of this reaction was not methylamine but benzylamine, which could not be understood by the authors.

I tried to modify the aromatic aldehyde component in several systematic experiments and found that in the *o*- or *p*-position to the aldehyde group there must be a group with free electrons significant enough to reduce fully the tendency of transamination in the Schiff's base.

An example is shown in the paper electropherogram given in Fig. 1. Using a mixture of valine and benzaldehyde the relation between formed benzylamine and *iso*butylamine was about 2 : 1 ; in the case of anisaldehyde it was about 1 : 1 (*p*-oxybenzylamine-methyl ether : *iso*butylamine) and finally, using *p*-dimethylaminobenzaldehyde, *iso*butylamine was the single product isolated after a method similar to that suggested by Curtius and Lederer[1]. The temperatures of decarboxylation increased for each amino-acid using *p*-dimethylaminobenzaldehyde instead of benz-

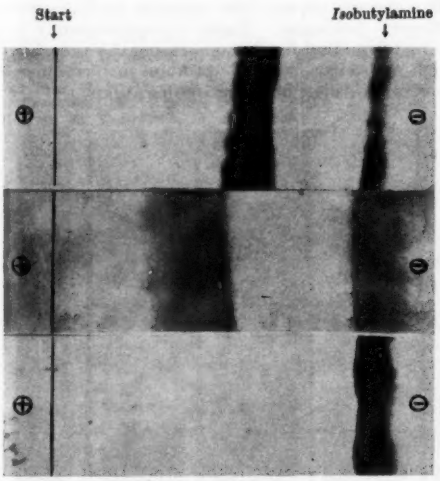
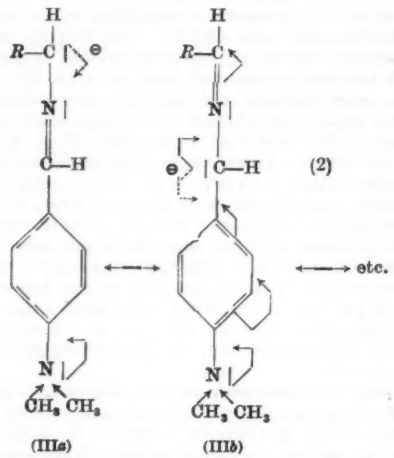


Fig. 1. Electrophoretic separation (ref. 2) of the amines obtained by decarboxylation of valine in the presence of different aromatic aldehydes (pH 6·0 ; 40 volts/cm. ; 40 min.) stained with ninhydrin. 1*a*, Benzaldehyde + valine → benzylamine + *iso*butylamine. 1*b*, Anisaldehyde + valine → *p*-oxybenzylamine-methyl ether + *iso*butylamine. 1*c*, *p*-dimethylaminobenzaldehyde + valine → *iso*butylamine



aldehyde as the catalytic aldehyde, but they never reached 200° C. (average value, 150° C.).

The yields for the formation of amines from most of the natural amino-acids are between 25 and 70 per cent of theory. But by this method it was not possible to get the corresponding amines of cystine, cysteine and tryptophan.

The mechanism of splitting the carbon dioxide from the Schiff's base and the significant reduction of the tendency of transamination using *p*-dimethylaminobenzaldehyde as aldehyde component may be understood from the accompanying formulæ.

In (1) the mesomeric states (II*b*), (II*c*), (II*d*), etc., are more probable than state (II*a*). By the influence of the free electrons in the dimethylamino-group of *p*-dimethylaminobenzaldehyde the analogous states (III*b*), etc., are suppressed (see ref. 2). Here state (III*a*) is more probable. This demonstrates the significantly lowered tendency towards transamination in this reaction.

Detailed results on this reaction will be published elsewhere.

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Preparation of Adrenocorticotropic Hormone from Fresh and Desiccated Hypophysis

In accord with H. B. F. Dixon and M. P. Stack-Dunne[1], who studied the behaviour of adrenocorticotropic hormone on a chromatographic column of a carboxy-type ion-exchange resin, we have found that the crude substance (I) prepared, according to the method of Lyons[2], from dry hypophysis powder previously desiccated by acetone is different from the crude preparation (II) extracted from fresh hypophysis by the same acid–acetone solvent. These preparations show different behaviour when we attempt their purification.

The adrenocorticotropic hormone content of preparation II is easily adsorbed by oxycellulose when treated with this adsorbent according to the method of Astwood and co-workers[3]. The greater part of the adrenocorticotropic hormone content of preparation I remains unadsorbed when so treated.

The crude preparations I and II both contain antidiuretic hormone in addition to the adrenocorticotropic hormone. We dissolved both I and II in 50 parts (v/w) of 0·01 *N* hydrochloric acid and stirred the solutions with 0·4 per cent (w/v) acid-washed bentonite. As the results of this treatment, the solution of (I) lost 15–20 per cent of its adrenocorticotropic hormone content and 70–75 per cent of its antidiuretic content; whereas a solution of (II) suffered a loss of 60–70 per cent of the former and only 30 per cent of the latter. We believe that these differences arise through the extensive modification of the bonds between low- and high-molecular weight polypeptides.

During the desiccating process, the bonds between metallic ions and polypeptides are also altered. The ash content of preparation I cannot be fully eliminated by an ion exchange process (treatment with 'Amberlite *IR* 120' and 'Amberlite *IRA* 400'), whereas the same process applied to preparation II gives a practically ash-free crude adrenocorticotropic hormone.

The differences between preparations I and II can be practically eliminated by dissolving preparation I in ten parts v/w of glacial acetic acid and precipitating the hormones with two volumes of ethyl ether. This treatment effects disintegration of bonds between high- and low-molecular weight polypeptides, most of which have their origin in the acetone desiccation process. The differences in these bonds lead to the different behaviour of preparations I and II with adsorbents. Paper chromatography (see below) demonstrates that the treatment of preparation I with glacial acetic acid augments its free and/or loosely bound adrenocorticotropic hormone polypeptide content.

Differences between preparations I and II could be demonstrated by descending paper chromatography using the solvent system, butanol/acetic acid/water (4 : 1 : 5). The water used for the preparation of this solvent system contained 1 per cent $FeSO_4.7H_2O$. Samples of crude adrenocorticotropic hormone were dissolved in 0·1 *N* acetic acid; the chromatograms were stained with amido-black 10*B* dissolved in ethanol. Figs. 1–3 show chromatograms of adrenocorticotropic hormone preparations differently treated. Spot (*a*) is a stationary component which contains a high-molecular weight protein and its adducts (for example, adduct with adrenocorticotropic hormone). Spot (*b*) contains the Van Dyke protein containing antidiuretic hormone[4]; spot (*c*) physiologically inert polypeptides and spot (*d*) the greater part of the free adrenocorticotropic hormone. The high-molecular weight polypeptides nearly disappear after oxycellulose purification of crude adrenocorticotropic hormone, with concomitant increase in the concentration of the strongly basic antidiuretic hormone and adrenocorticotropic hormone polypeptides (Fig. 3).

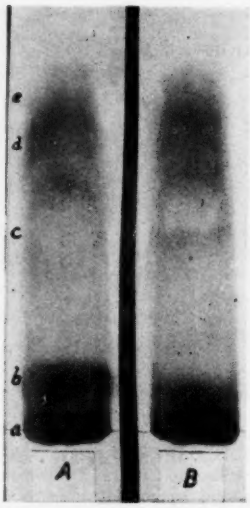

Fig. 1. Preparation I: before (*A*) and after bentonite treatment (*B*). Duration of the chromatographic run, 50 hr.

Fig. 2 demonstrates that preparation II contains more of the quickly moving component, which proved to be adrenocorticotropic hormone, than preparation I. The chromatograms also indicate the presence of antidiuretic hormone. Paper chromatography is a convenient method for demonstrating the presence of a high-molecular weight protein in commercial adrenocorticotropic hormone preparations.

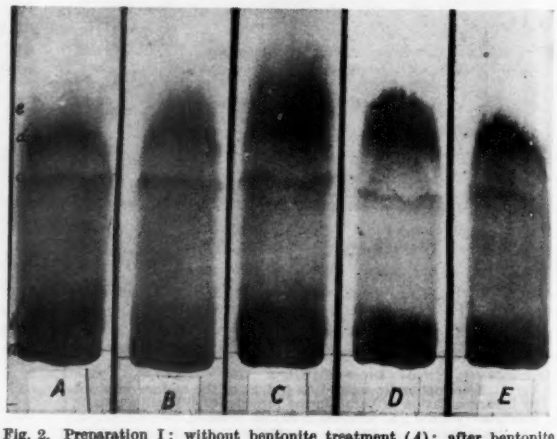

Fig. 2. Preparation I: without bentonite treatment (*A*); after bentonite treatment (*B*); after glacial acetic acid treatment (*C*). Preparation II: before (*D*) and after (*E*) treatment with bentonite. Duration of the chromatographic run, 20 hr.

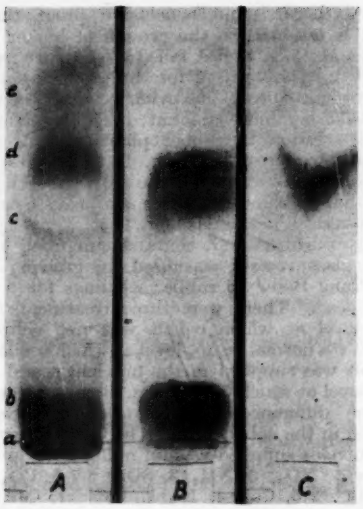

Fig. 3. Preparation II: without treatment (*A*); after purification with oxycellulose (*B*); adiuretin-free, purified with oxycellulose (*C*). Duration of the chromatographic run, 20 hr.

In the experiments described, recoveries of activities were followed by appropriate bioassay methods. The adrenocorticotropic hormone activity of the paper chromatographic components was measured routinely by a frog method modified by one of us[5], and the vasopressin activity was measured in the decapitated cat.

Details of this work will be published elsewhere.

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Vacuolated Neurones in Sheep affected with Scrapie

Holman and Pattison[1] reported the occasional presence of homogeneous eosinophilic granules in vacuolated neurones of the medulla from sheep affected with scrapie. Palmer[2], in a recent communication, described similar eosinophilic bodies inside the vacuoles in eight sheep suffering from scrapie, and concluded that these bodies did not occur in vacuoles of healthy sheep. This observation of Palmer appears to be in contrast to the work of Zlotnik and Rennie[3], who carried out an extensive study of medullas from fifty-seven apparently healthy sheep; they recorded the occurrence of vacuolated neurones in a high proportion of the animals and observed inside some of the vacuoles eosinophilic bodies identical with these described by Palmer.

Eosinophilic bodies in non-vacuolated cells similar to these observed by Palmer in scrapie have been described by Brownlee and Wilson[4] in the cells of the spinal ganglia from healthy sheep and in animals affected with louping-ill. In my experience, apart from mitochondria and Golgi bodies, two other structures can be demonstrated in the neurones of the medulla from both healthy and scrapied animals. One body appears in the form of discrete granules of various sizes, the biggest being similar to a large nucleolus. These bodies are highly eosinophilic, but may be stained also with Heidenhain's iron hæmatoxylin. They are, however, negative in the following methods: Feulgen reaction, periodic acid – Schiff, Kurnick's methyl-green-pyronin, aldehyde fuchsin (Gomori's), and sudan IV in both frozen and paraffin-embedded material. The second structure encountered in the neurones of the medulla is in the form of aggregations of small granules often in a juxta-nuclear position. These granules are either absent or very scanty in young animals, but increase in numbers in sheep more than two years old. These bodies do not stain with eosin, phloxine or iron hæmatoxylin, but stain very well with aldehyde fuchsin (Gomori's), they are acid-fast, positive with periodic acid – Schiff reagent and give a very weak reaction with Feulgen's method; however, they may be stained with Schiff's reagent without prior oxidation or hydrolysis. In sudan IV they stain a brick-red colour in both frozen and paraffin-embedded sections.

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Restoration of Sodium-deficient Frog Nerve Fibres by Onium Ions

Since guanidinium ions have proved to be able to restore conduction of impulses by sodium-deficient frog *A* fibres[1], it seemed desirable to ascertain whether other ionized compounds possessing a tetracovalent nitrogen atom (onium ions) also can substitute for sodium. An extensive, but not exhaustive, research has revealed that, in addition to guanidinium ions, five onium ions can restore conduction by sodium-deficient frog *A* fibres: formamidinium, aminoguanidinium, hydrazinium, hydroxylammonium and ammonium ions.

In all instances the active chemical species are the ions. This is obvious in the case of bases as strong as formamidine, guanidine or aminoguanidine and even in the case of ammonia, since the ionization of this base is practically complete at *p*H 7. In the cases of hydrazine and hydroxylamine the following observations prove that the activity is due to the hydrazinium or hydroxylammonium ions present in the solution.

A 0·01 *N* solution of hydrazine hydrochloride fails to restore sodium-deficient nerve fibres if the *p*H is adjusted to 7·8, but if the *p*H is adjusted to 7·5 the solution has approximately the same restoring ability as a 0·008 *N* solution at *p*H 7. In the absence of calcium ions the last solution and a 0·006–0·007 *N* solution of sodium ions restore the ability to conduct impulses to approximately one-fifth of the *A* fibres.

The effect of changes in *p*H on the activity of hydrazine agrees with the known value of its first ionization constant[2], $8{\cdot}5 \times 10^{-7}$.

The proof is even more dramatic in the case of hydroxylamine. For example, (*a*) a 0·025 *N* solution of hydroxylamine hydrochloride does not restore any nerve fibre if the *p*H is adjusted to 7·6, but it promptly restores a large number of the *A* fibres if the *p*H is adjusted to 6·6; (*b*) a 0·02 *N* solution of hydroxylamine hydrochloride does not restore any *A* fibre if the *p*H is 7; it restores a few fibres if the *p*H is lowered to 6·6, and it restores about one-fifth of the *A* fibres if the *p*H is lowered to 6·4. In view of these results and taking into account the order of magnitude of the ionization constant of hydroxylamine[2], $6{\cdot}6 \times 10^{-9}$, it can be estimated that at a concentration certainly not higher than 0·005 *N*, hydroxylammonium ions can restore the ability to conduct impulses to approximately one-fifth of the *A* fibres.

Neither hydrazinium nor hydroxylammonium ions seem to exert a depolarizing action upon the nerve fibres. The other restoring ions do have a depolarizing action; the effect is weak in the case of guanidinium and aminoguanidinium ions so that a number of the restored fibres can conduct impulses for as long as two hours or even longer. The depolarizing action of formamidinium ions is somewhat stronger, and that of ammonium ions is very strong, for which reason the restoring action of ammonium ions lasts only for a small number of minutes. That the fibres restored by ammonium ions again lose their excitability because they undergo a depolarization is proved by the fact that by raising the membrane potential by means of an applied anodal current the conduction block is relieved. The transitory character of the restoration of sodium-deficient *A* fibres by ammonium ions may explain why no restoration was observed in previous experiments[3].

More than seventy derivatives of the restoring ions have been tested on sodium-deficient nerves. In the absence of sodium none has proved to be able to restore conduction by any nerve fibre. A few are able to enhance the restoring ability of small concentrations of sodium ions (0·005–0·008 *N*) and a number of them rapidly block conduction in the presence of concentrations of sodium ions (0·025–0·08 *N*) that by themselves would maintain conduction of impulses for extended periods of time.

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A Beneficial Effect of Cobalt on the Growth of the Rubber Plant (*Hevea brasiliensis*)

Without adequate cobalt, ruminants will develop symptoms, sometimes referred to as enzootic marasmus or pining, and will die if not resuscitated with either cobalt or vitamin B_{12} [1,2]. Cobalt has also been demonstrated to be an essential element required by certain blue-green algae[3]. However, while it has been demonstrated that cobalt will materially increase the elongation of stem segments in the presence of sugars[4,5], there is no conclusive proof that the element is essential to the growth of higher plants. Hewitt and Bolle-Jones[6] failed to produce evidence that cobalt was essential for the growth of tomato, lettuce or sugar-beet. The evidence summarized here shows that a minute amount of cobalt supplied in nutrient solution to rubber plants grown in sand significantly improved growth. It shows that cobalt has a beneficial effect on the growth of a higher plant; but this, in itself, does not prove it to be an indispensable nutrient element.

Highly purified sand, contained in freely drained 'Pyrex' glass vessels, was used for growing 'selfed' clone Prang Besar 86 rubber seedlings for a period of one year. There were three treatments: a nil or Co_1-level at which cobalt was not deliberately supplied: a normal or Co_2-level at which 0·005 p.p.m. of cobalt was supplied in the nutrient; and a high or Co_3-level at which 0·25 p.p.m. of cobalt was given. The one difference between treatments was the variation in the cobalt level. The composition of the basal nutrient supplied was (in milligram equivalents per litre): NO_3^- 5, NH_4^+3, SO_4^{--} 7·5, PO_4^{---}3, K^+3, Mg^{++}2·5, Ca^{++}4, Na^+1, Fe^{+++}1, Mn^{++}0·02, BO_3^{---}0·033, Cu^{++}0·002, Zn^{++}0·002, Mo^{VI}0·001,

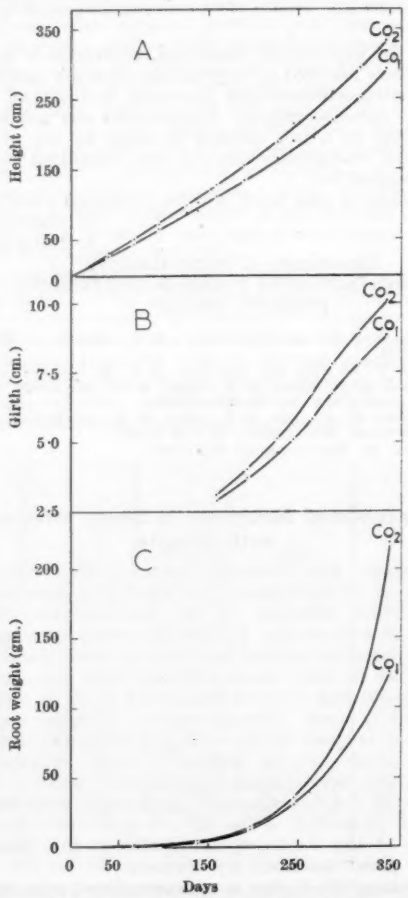
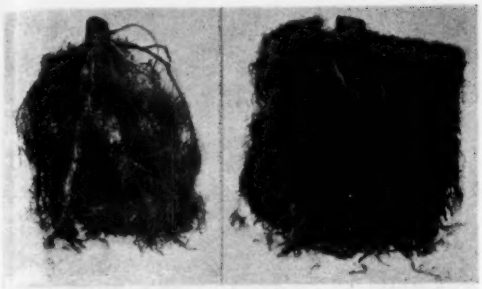


Fig. 1. Height (*A*), girth (*B*) and dry weight of root (*C*) values for cobalt-deficient (Co_1) and healthy (Co_2) rubber plants



(Co_1) (Co_2)

Fig. 2. Roots of cobalt-deficient (Co_1) and healthy (Co_2) one-year-old rubber plants

Al^{+++}0·001, Ni^{++}0·0002 and Ga^{+++}0·0002. The salts of the macronutrient elements and manganese sulphate were freed from cobalt by complexing the cobalt ions with nitroso-*R* salt and/or α-nitroso β-naphthol at a neutral *p*H and removing the cobalt complex and the excess organic reagent by adsorbing them on activated carbon. The salts of the micronutrient elements, other than manganese sulphate, were purified by recrystallization. Fuller details will be published elsewhere.

Although symptoms definitely attributable to cobalt deficiency were not recorded, growth effects due to the deficiency were recorded and are shown in Figs. 1 and 2. In general, the Co_2 plants showed effects intermediate between the Co_1 and Co_2 plants but, for the sake of clarity, data obtained from them are not included in the graphs. Cobalt-deficient (Co_1) plants possessed a smaller height, girth of stem and dry weight of root per plant than did plants grown at the adequate level of cobalt (Co_2). An evaluation of these data, after transformation to linearity, showed that for the dry weight of roots per plant and for girth, the differences between the slopes of the regression lines for the Co_1 and Co_2 values were significant at the 5 per cent level but that for height the 0·1 per cent level of significance was achieved.

A subsidiary experiment using tomato as the test plant showed no significant difference in the dry weight per shoot and root between the Co_1 and Co_2 plants, but the fresh weight of fruit produced was halved in the cobalt-deficient plants.

The absolute cobalt content of the Co_2 and Co_3 plants increased with time; the rate of increase was much smaller for the Co_1 plants which, at the end of the experiment, contained no more than 10 μgm. of cobalt per plant, of which approximately 0·5 μgm. came from the seed and the rest must have been derived either from the sand, nutrients, or from casual dust contamination. The normal or Co_2 plants contained approximately 250 μgm. of cobalt per plant at the end of the experiment. The concentrations of cobalt found in the laminæ at the end of the experiment were, in terms of p.p.m. of dry matter: Co_1 0·02, Co_2 0·36, Co_3 4·42. A comprehensive chemical analysis for most of the nutrient elements revealed the interesting fact that, despite growth differences, cobalt-level did not have any marked effect on the accumulation of nitrogen, phosphorus, magnesium or potassium in the tissues. Sometimes, but not always, the calcium and iron concentration within the roots significantly increased as the cobalt level varied from Co_1 to Co_2 but these effects were not consistent for all samplings.

The suggestion[7] that the cobaltous ion is capable of either reducing peroxigenesis or decomposing the peroxides as they are formed, before they can be utilized in peroxidative reactions and thus curtail the destruction of indole acetic acid, might account for the general shoot growth effects recorded here and for the lack of marked effects or interactions with other essential nutrient elements.

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Effect of Temperature on the Development of *Tetranychus telarius* L.

In view of the economic importance of the glasshouse red spider mite, it is desirable that the effect of environment on its rate of development be accurately determined in order that the intervals between applications of acaricide can be estimated effectively. The only available experimental figures are those of Van Marle[1] and of Linke[2], and these are either based on a few scattered observations or cover an outdoor temperature-range too low to be applicable to glasshouse conditions. As our results suggest a more rapid development at high temperatures than has hitherto been assumed, we are publishing some preliminary figures in Table 1.

Table 1. Rate of Development of Female *Tetranychus telarius* L. at Constant Temperatures

Temp. (° F. ± 1·0°)	Incubation period of eggs (days)	Period of development (days)				
		Larva	Proto-nymph	Deuto-nymph	Total	S.E.
70	5·9	2·5	2·2	2·7	7·4	± 0·10
75	4·6	1·9	1·6	2·2	5·7	± 0·06
80	3·6	1·5	1·2	1·7	4·4	± 0·06
85	2·9	1·2	1·0	1·4	3·6	± 0·04
90	2·7	1·1	1·0	1·3	3·4	± 0·03
95	2·3	1·2	1·2	1·7	4·1	± 0·16

Note: The stadia combine both active and resting phases.

An initial stock of the red form of *T. telarius* (considered by some workers to be *T. cinnabarinus* Bois[3]) from arum lily was started by inbreeding from a single female. Using the floating-disk technique[4], mites were kept upon French bean in glass-fronted incubators with 16-hr. illumination daily from mercury vapour lamps. The cultures were examined three times a day and only those eggs laid within the previous 4-hr. period were used for development data. These eggs were marked with coloured cardboard pointers. Larvæ hatching on the same day were afterwards maintained on separate disks. A parallel series of experiments carried out in total darkness gave closely comparable results, but for each temperature the total development period was prolonged by about 12 hr. At 95° F., frequent transference of the mites to fresh disks was necessary owing

to rapid deterioration of the latter. These repeated changes appeared to affect the mites adversely and were no doubt responsible for the apparent retardation in development.

Similar data have been accumulated for male mites. Their total development period was about 0·6 day less than that of the females over the whole temperature-range.

This work is being extended into the lower temperature-ranges and special attention is to be paid to the effects of the considerable diurnal temperature-range experienced under glass.

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A New Trematode, *Poikilorchis congolensis*, n.g., n.sp., living in Subcutaneous Retroauricular Cysts in Man from the Belgian Congo

Yarwood and Elmes[1] observed a cyst in the retroauricular region of a native in Nigeria, containing operculated eggs having the same form as the eggs of *Paragonimus*. Recently, one of us discovered, in natives of the Kasai Province, four cases of cysts or abscesses, similarly situated and containing eggs resembling those of *Paragonimus westermani* but slightly smaller in size[2]. Examination of an adult worm extracted from one of these cysts showed that it did not belong to the Troglotrematidae (although it had some of the characteristics of this family) but to the Achillurbainiidae Dollfus[3]. At the present time this family is represented by only one genus containing one species *Achillurbainia nouveli* Dollfus, which was discovered in an abscess of the upper eyelid in a Malayan leopard. Our specimen has certain differences from the genus *Achillurbainia* and we propose to place it in a new genus and in a new species: *Poikilorchis congolensis* n.g., n.sp.

The worm is brown (in formalin), flattened, 7·6 mm. long and 3·9 mm. wide; oral sucker terminoventral and smaller than the acetabulum, which is situated about one-third of the distance along the body; cuticle non-spinous and non-scaly. The prepharynx is absent, pharynx well developed, œsophagus dorsoventral and very short; the cæca reach about the end of the body and have very numerous folds. The excretory vesicle is I-shaped and slightly widened anteriorly. The ovary is ovoid, regular in shape and not lobate, situated to the left of the median line, a little behind the acetabulum; uterus contains numerous eggs, lying between the two cæca, the posterior border of the ovary and the acetabulum; receptaculum seminis small, bilobate, situated medially; testes very numerous (about two hundred) and very irregular in shape, situated in the posterior two-thirds of the body; seminal vesicle large, situated in front of the acetabulum; cirrus pouch and copulatory organ absent; genital pore situated in front of the acetabulum a little to the right of the median line; vitellaria very numerous filling almost all the body; eggs operculated, without a spine opposite the operculum, 0·063 mm. long and 0·04 mm. wide (Fig. 1).

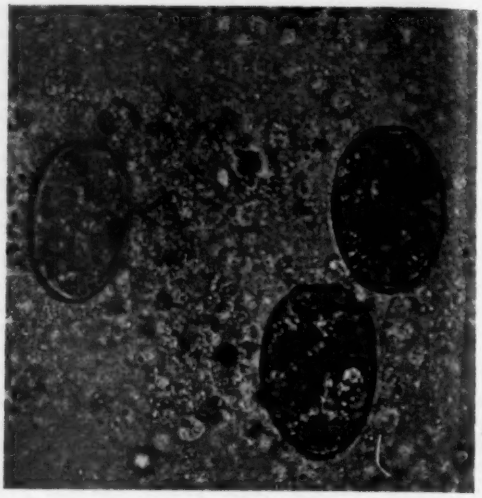

Fig. 1. Eggs of *Poikilorchis congolensis* n.g., n.sp., found in a retroauricular cyst

This new genus is distinguished from the genus *Achillurbainia* by the following characters: testes very irregular in shape, cæca having very numerous and short folds, receptaculum testis small, bilobate and median, genital pore paramedian, ovary ovoid.

It is notable that none of the four patients from Kasai suffered from pulmonary paragonimiasis and did not have eggs in the sputum. However, two of these patients were inhabitants of villages where so-called pulmonary paragonimiasis had been previously observed. Considering the dimensions of the eggs found in a case reported by Libert in the Cameroons[4], we think that it is probable that some of the cases reported as pulmonary paragonimiasis in Africa are in fact caused by this new parasite.

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An Interchange Heterozygote in *Vicia faba*

During cytological investigations into the action of ethyleneimines upon root-tip cells of *Vicia faba*, variety Sutton's Seville Long Pod, one treated seedling was found in which all dividing cells possessed a chromosome complement differing from that of the normal seedlings. Observations and measurements of the chromosome complement, carried out on eight metaphase cells from normal seedlings, showed that it was possible to recognize, apart from pairs 3 and 4,

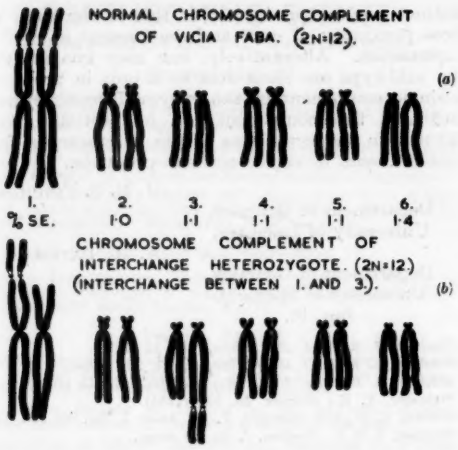

Fig. 1. Semi-diagrammatic representation of the chromosomes from colchicine-arrested metaphase cells from root-tips of (*a*) normal seedlings of *Vicia faba*, and (*b*) an interchange heterozygote. Percentage standard errors are calculated from eight normal cells using chromosome I as standard

each of the six pairs of homologues by the length of their long arms. Pairs 3 and 4 could be distinguished from one another by the size of their short arms. The six pairs of homologous chromosomes of the normal complement are shown diagrammatically in Fig. 1*a*, together with the complement of the treated seedling in Fig. 1*b*.

In the normal complement, nucleolar-organizer constrictions are present in the long chromosomes (pair 1); in the aberrant seedling, however, only one of the long chromosomes had a nucleolar-organizer constriction, while the second constriction was found attached to the long arm of one of the chromosomes of pair 3 (Figs. 1*b*, 2). Further examination showed that the seedling was heterozygous for an interchange. Measurements of the aberrant chromosomes suggest that the probable points of interchange were situated immediately proximal to the nucleolar-organizer constriction of one homologue of chromosome 1, and at the distal end of the long arm of one homologue of chromosome 3. At or near these points heterochromatic regions have been demonstrated[1,2], and although our observations are not conclusive it is likely that the interchange occurred in the heterochromatic material.

Examination of the interphase cells showed the normal 1 or 2 nucleoli and the cells appeared morphologically similar in every respect to those of seedlings with a normal complement. Although the seedling had received treatment with the radiomimetic agent triethylene melamine, it was obvious that this had not induced the interchange.

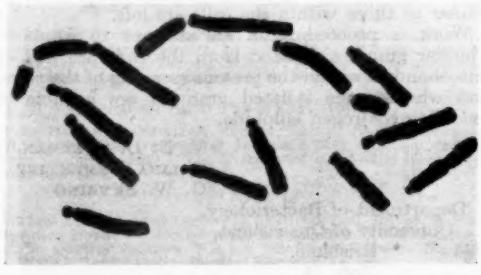

Fig. 2. Metaphase from root-tip cell of *Vicia faba* with interchange. Material fixed in 2 *BD*, after 4 hr. pretreatment with colchicine, stained leuco-basic fuchsin (× 925)

It has been suggested that the nucleolar-organizer in chromosome 1 is situated at the proximal end of the nucleolar constriction[1], but no structure for this constriction has been reported in the literature. However, a definite staining reaction was often observed. The distal part of the constriction (about two-thirds of its total length) was faintly stained, terminating in a more deeply stained knob, while the proximal third, apparently the nucleolar-organizer, remained unstained (Fig. 2).

In the genus *Vicia*, the species show great differences not only in chromosome size but also in the position of the nucleolar-organizer constriction[3]; these occur in many species at the distal end of chromosomes with subterminal centromeres, as in the interchange here described. One case of translocation has been reported in the hybrid *Vicia sativa* × *V. augustifolia*[4], although interchange heterozygotes have not, so far as I can ascertain, been observed previously in *V. faba*. The seedling reported here was indistinguishable from the normal ones and was discarded prior to the examination of the root-tip cells. It was a single instance discovered in several hundred seedlings examined during investigations supported by the British Empire Cancer Campaign.

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Formation of an Enzyme through Complementary Action of Mutant 'Alleles' in Separate Nuclei in a Heterocaryon

The *am* mutants of *Neurospora crassa* require exogenous α-amino nitrogen for normal growth and lack detectable glutamic acid dehydrogenase[1,2]. Several such mutants are now known; all are phenotypically similar, and all, on the basis of limited genetic evidence, have hitherto been regarded as due to mutation at the same locus.

Strains descended from the original X-ray mutants numbers 32213 and 47305 of the original Beadle and Tatum series will be referred to by the gene symbols am^{32} and am^{47} respectively. Neither of these mutants forms detectable glutamic dehydrogenase, either when grown in medium supplemented with amino-acid or after physiological adaptation to growth in minimal medium (such an adaptation can occur after a prolonged lag which can be shortened by the use of large inocula). Crosses of am^{32} × am^{47} show very little, if any, genetic recombination. Out of 197,000 ascospores examined from the cross, only two genetically wild type ascospores have been recovered, and chance mutation, contamination and gene conversion[3] have not been excluded as possible sources of these exceptional spores. On the other hand, ascospores which appear semi-wild when germinated on a selective medium (unpublished work

Table 1

Strain	Duration of growth (25°) (hr.)		0·002 *M* glutamate added to minimal medium	Specific glutamic dehydrogenase activity (units/mgm. protein)
Pseudowild from $am^{32} \times am^{47}$		48	−	60
am isolates from pseudowild	1	64	−	0 (<3)
	1	48	+	0 (<0·2)
	2	88	−	0 (<0·6)
	2	48	+	0 (<0·4)
	3	64	−	0 (<2)
	3	48	+	0 (<2)
	4	88	−	0 (<1)
	4	48	+	0 (<0·7)
Heterocaryons	(1+4)	64	−	75
	(2+3)	64	−	82
	(3+4)	64	−	84
Wild type (St. Lawrence *A*)		48	−	>270

For experimental details, see ref. 6.

by J. A. P.) occur with a frequency of about 0·05 per cent in $am^{32} \times am^{47}$ crosses, though not in $am^{32} \times am^{32}$ or in $am^{47} \times am^{47}$ crosses. Cultures grown from these semi-wild ascospores grew poorly on minimal medium in comparison with wild type, were strongly stimulated by added alanine, and behaved genetically as pseudowilds, that is, strains containing complementary homologous mutant chromosomes originally included in the same ascospore nucleus and later becoming segregated into different nuclei[4].

Eight *am* strains were isolated from single conidia from a pseudowild culture. In order to reconstitute heterocaryons, thick mixed suspensions of conidia from pairs of these *am* isolates were spotted on to sorbose agar[5], and, after incubation, pieces of the resulting pellets of growth were isolated. The eight *am* isolates fell into two groups of four, presumably corresponding to am^{32} and am^{47} respectively. Pairings within each group gave ordinary *am* cultures, while all pairings involving one isolate from each group gave cultures resembling the original pseudowild culture in growth properties. These reconstituted heterocaryons were thereafter maintained on minimal medium. Table 1 shows the results of enzyme assays on extracts of pseudowild type, of the homocaryotic *am* strains derived from it, and of heterocaryons produced from them. The *am* strains were grown in minimal medium as well as in medium supplemented with glutamate; sufficient growth can be obtained in minimal medium in the times indicated if very large inocula are used.

It is clear that $am^{32} + am^{47}$ heterocaryons are able to produce glutamic dehydrogenase, though at a level considerably less than the wild type, and that it makes little difference whether the heterocaryons originate as pseudowilds or by vegetative hyphal fusion.

These results might be readily explained if 'glutamic dehydrogenase' of *Neurospora* were really two enzymes, acting in sequence. This seems unlikely on grounds of comparative biochemistry, and the possibility that am^{32} can form one enzyme, and am^{47} a second, complementary, enzyme, appears to be virtually ruled out by experiments in which we have failed to detect activity either in mixtures of am^{32} and am^{47} extracts or in extracts of mixtures of am^{32} and am^{47} mycelium.

Assuming that glutamic dehydrogenase is a single enzyme, two main interpretations of the results seem possible. It may be supposed that the synthesis of the enzyme includes two steps mediated by two distinct nuclear products. If this is the case, the close proximity of am^{32} and am^{47} seems in need of explanation. Alternatively, one may imagine that the wild-type *am* locus acts as a unit in producing a single component of the enzyme-forming system, and that this component can be partially reconstituted in the cytoplasm of the heterocaryon from two different defective nuclear products.

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Deposition of Sulphur from Hydrogen Sulphide by Bacteria and Yeast

It has recently been shown[1] that *Sphaerotilus natans*, when grown in 0·1 per cent peptone and afterwards exposed to an atmosphere of hydrogen sulphide, deposits sulphur intracellularly. Under phase contrast, there was a suggestion that the oxidation was associated with distinct granules within the cells. It has since been shown that these granules have properties attributed to mitochondria. Acting on the hypothesis that any large cell with well-defined granules would deposit sulphur intracellularly under similar conditions, several yeasts and one unidentified species of the fungus *Alternaria* were similarly treated.

Pellicle-forming yeasts, including *Pichia membranefaciens*, showed quite rapid oxidation of the hydrogen sulphide, the intracellular deposition of sulphur being associated again with granules giving reactions attributed to mitochondria. Not all granules had the same activity. The culture of *Alternaria* sp. also showed active oxidation of the hydrogen sulphide but has not yet been more critically examined.

The activity of yeasts and *Sphaerotilus natans* is increased by aeration of the cultures prior to exposure. Prolonged gassing with nitrogen inhibits the reaction.

In aged yeast cultures, considerable quantities of globular sulphur appear outside the cells. Where clusters of the globules have been extracted with pyridine, clusters of granules having an appearance similar to those within the cells are left.

Work is proceeding in an attempt to establish whether granules isolated from the cells are in fact mitochondria within the present meaning of the term, and whether the isolated granules are capable of oxidizing hydrogen sulphide.

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FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, April 8

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (in the Reynolds Hall, College of Technology, Manchester), at 5.45 p.m.—Dr. A. R. Hall: "Decisions in Science".

SOCIETY OF CHEMICAL INDUSTRY, CORROSION GROUP (at 14 Belgrave Square, London, S.W.1), at 6.30 p.m.—Prof. R. Piontelli (Milan): "Recent Research at Milan on the Electrochemistry of Corrosion".

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.30 p.m.—Mr. John Kempe, Mr. George Band and Mr. Michael Westmacott: "Exploration of Huagaruncho".

Monday, April 8—Friday, April 12

SECOND INTERNATIONAL CONGRESS OF SURFACE ACTIVITY (at Senate House, University of London, W.C.1, and the Institute of Education, Malet Street, London, W.C.1).

Tuesday, April 9

INSTITUTION OF MECHANICAL ENGINEERS, AUTOMOBILE DIVISION (at 1 Birdcage Walk, Westminster, London, S.W.1), at 4.30 p.m.—Symposium on "Superchargers and Supercharging".

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N.W.1), at 5 p.m.—Scientific Papers.

INSTITUTION OF BRITISH AGRICULTURAL ENGINEERS (at 6 Buckingham Gate, London, S.W.1), at 5.30 p.m.—Mr. T. C. D. Manby: "Recent Developments in Tractor Testing Techniques at the N.I.A.E.".

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Mr. H. D. Morgan: "Control of Flow by Gates and Valves".

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENT AND CONTROL SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. E. R. Hartill, Mr. J. G. McQueen and Mr. P. N. Robson: "A Deep Electrolytic Tank for the Solution of 2- and 3-Dimensional Field Problems in Engineering".

INSTITUTION OF THE RUBBER INDUSTRY (at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 6.30 p.m.—Annual General Meeting.

Wednesday, April 10

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—(the late) Mr. D. Leitch, Mr. T. R. Owen and Mr. D. G. Jones: "The Basal Coal Measures along part of the North Crop of the South Wales Coalfield"; Mr. L. G. Love: "Micro-organisms and the Presence of Syngenetic Pyrite".

INSTITUTE OF FUEL (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 5.30 p.m.—Dr. Hans Koppers: "Koppers-Totzek Gasification Process".*

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP—NUTRITION PANEL (at 14 Belgrave Square, London, S.W.1), at 6.15 p.m.—Annual General Meeting. 6.30 p.m.—Prof. J. Yudkin: "Diet and Coronary Disease—Some Correlations and Speculations" (Chairman's Address).

BRITISH INSTITUTION OF RADIO ENGINEERS (in the Lecture Theatre of the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 6.30 p.m.—Mr. R. W. Stobbs: "The Uses of Electro-plated Coatings in the Electronics Industry".

CEMENT AND CONCRETE ASSOCIATION (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6.30 p.m.—Mr. Derrick Beckett and Mr. B. J. S. Walls: "An Introduction to Pre-stressed Concrete in Highway Engineering".

INSTITUTION OF MECHANICAL ENGINEERS, LUBRICATION GROUP (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6.45 p.m.—Discussion on "Standardization of Lubricants".

Thursday, April 11

INSTITUTION OF ELECTRICAL ENGINEERS, UTILIZATION SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. E. Bates: "Development of Transportable Thermal-Storage Space Heaters"; Mr. J. W. Moule and Mr. W. M. Stevenson: "Electrical Floor Warming".

SOCIETY OF CHEMICAL INDUSTRY, ROAD AND BUILDING MATERIALS GROUP (at 14 Belgrave Square, London, S.W.1), at 6 p.m.—Annual General Meeting. Mr. Jacques Bellanger: "Rupture et Adhésivité des Emulsions de Bitume anioniques et cationiques".

Thursday, April 11—Friday, April 12

NATIONAL ASSOCIATION FOR MENTAL HEALTH (in the Assembly Hall, Church House, Westminster, London, S.W.1), at 10 a.m. daily—Annual Conference 1957—"The Maladjusted Child—The Underwood Report and After".

Friday, April 12

BRITISH MEDICAL ASSOCIATION (in the Great Hall, British Medical Association House, Tavistock Square, London, W.C.1), at 5.30 p.m.—Prof. Sir Geoffrey Jefferson, F.R.S.: "Sir Victor Horsley—His Life and Work" (Tenth Victor Horsley Memorial Lecture).

INSTITUTION OF MECHANICAL ENGINEERS, APPLIED MECHANICS GROUP (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6 p.m.—Dr. S. A. Tobias and Dr. R. N. Arnold: "The Influence of Dynamical Imperfection on the Vibration of Rotating Discs".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

HEAD (with high academic qualifications, preferably an honours degree in mining, practical mining experience, and teaching experience, preferably in a technical college or university) OF THE MINING AND GEOLOGY DEPARTMENT—The Principal, Wigan and District Mining and Technical College, Wigan (April 12).

LECTURER (with an honours degree in engineering, together with industrial, teaching or research experience) IN MECHANICAL/CIVIL ENGINEERING; and an ASSISTANT (with an honours degree in engineering) IN MECHANICAL ENGINEERING—The Secretary, The University, Edinburgh (April 13).

PHYSICS LABORATORY ASSISTANT (with at least Inter.B.Sc., M.S.R. or equivalent), to assist in measurements in the application of radioactive isotopes to medical problems—The Personnel Officer, St. Thomas's Hospital, London, S.E.1 (April 13).

LECTURER (graduate in medicine or science and postgraduate experience in some branch of physiology) IN PHYSIOLOGY in the Faculty of Medicine, University of Birmingham—The Assistant Registrar, Medical School, Birmingham 15 (April 15).

LECTURER (with a good physics degree or corporate member of the Institute of Physics, and preferably teaching experience) IN PHYSICS—The Principal, North Staffordshire Technical College, Stoke-on-Trent (April 20).

SENIOR LECTURER (with qualifications in either pure or applied mathematics) IN MATHEMATICS at Canterbury University College, Christchurch, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, April 20).

MEDICAL ENTOMOLOGIST (preferably with at least a second-class honours B.Sc. degree with entomology or zoology as major subjects, or a higher academic qualification) in the Ministry of Health, Federation of Rhodesia and Nyasaland—The Secretary (R), Rhodesia House, 429 Strand, London, W.C.2 (April 24).

PROFESSOR OF CIVIL ENGINEERING; a PROFESSOR OF ELECTRICAL ENGINEERING; and a PROFESSOR OF MECHANICAL ENGINEERING, at the University of Roorkee, Roorkee—High Commissioner of India, Establishment Department, India House, Aldwych, London, W.C.2 (April 26).

LECTURERS IN ELECTRICAL ENGINEERING; LECTURERS (with special qualifications in the fields of inorganic, physical or theoretical chemistry) IN CHEMISTRY; LECTURERS IN AGRICULTURE (ANIMAL HUSBANDRY); and LECTURERS IN SOIL PHYSICS—The Registrar, King's College, Newcastle-upon-Tyne (April 27).

FELLOW (with an honours degree in physics and/or mathematics) IN THE DEPARTMENT OF ASTRONOMY, Research School of Physical Sciences, Australian National University—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, April 29).

LECTURERS IN (*a*) PHYSIOLOGY AND BIOCHEMISTRY (Veterinary Pre-Clinical Department); and (*b*) CLINICAL METHODS AND DIAGNOSIS (Department of Animal Health), in the Faculty of Veterinary Science, University of Khartoum—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (April 30).

SENIOR LECTURER, and a LECTURER or DEMONSTRATOR (with medical qualifications registrable in this country) IN PATHOLOGY—The Registrar, The University, Leeds 2 (April 30).

SENIOR LECTURER IN CHEMISTRY; a SENIOR LECTURER IN PHYSICS; a LECTURER IN PHYSICS; a LECTURER IN BIOLOGY; ASSISTANT LECTURERS (2) IN CHEMISTRY; and a LECTURER or ASSISTANT LECTURER IN MATHEMATICS at the Royal Technical College of East Africa, Nairobi—The Advisory Committee on Colonial Colleges, 1 Woburn Square, London, W.C.1 (April 30).

UNIVERSITY STUDENTS and FELLOWS for experimental or theoretical research in solid state physics—The Professor of Natural Philosophy, The University, Glasgow (April 30).

ENGLISH ELECTRIC RESEARCH FELLOW IN AERONAUTICS, for post-graduate research into problems of vibration or stability and control of aircraft—The Warden, College of Aeronautics, Cranfield, Bletchley, Bucks (May 1).

POSTDOCTORAL FELLOWS (two or more) for research on a variety of problems in organic chemistry—The Administrative Officer, Dyson Perrins Laboratory, The University, South Parks Road, Oxford (May 1).

UNIVERSITY DEMONSTRATOR (with an honours degree in pure science with organic chemistry and biochemistry as principal subjects) IN ANIMAL NUTRITION—The Secretary, School of Agriculture, The University, Cambridge (May 1).

ASSISTANT KEEPER (with a British university degree or equivalent) OF THE DEPARTMENT OF ARCHÆOLOGY—The Director, Museum and Art Gallery, Congreve Street, Birmingham 3 (May 6).

ASSISTANT LECTURER (preferably with special qualifications in plant physiology) IN BOTANY; a LECTURER (preferably with research experience in valve or circuit electronics) IN THE DEPARTMENT OF ELECTRONIC ENGINEERING; and a LECTURER IN THEORETICAL PHYSICS—The Secretary and Registrar, University College of North Wales, Bangor (May 6).

DIRECTOR OF THE DEPARTMENT OF EDUCATION—The Registrar, University Registry, Oxford (May 9).

CHAIR OF GEOGRAPHY in the University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, May 15).

LECTURER or ASSISTANT LECTURER IN PHILOSOPHY at the University of Malaya—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (May 15).

CHAIR OF MATHEMATICS in the University of New England, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, May 31).

RESEARCH FELLOW (ORGANIC CHEMIST); and a SENIOR RESEARCH FELLOW or RESEARCH FELLOW (PHYSICAL-ORGANIC CHEMIST, with

special experience in spectroscopy) IN THE DEPARTMENT OF MEDICAL CHEMISTRY, John Curtin School of Medical Research, Australian National University—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (May 31).

RESEARCH OFFICER, Principal Scientific Officer or Senior Principal Scientific Officer grade (either member of the Royal College of Veterinary Surgeons or with a qualification registrable with that body), TO TAKE CHARGE OF THE SECTIONS OF VIROLOGY AND PATHOLOGY—The Director, Houghton Poultry Research Station, Huntingdon (May 31).

SCIENTIFIC ASSISTANT (with an honours degree in biological sciences, or a knowledge of foreign languages, and the ability to write correct English) AT THE COMMONWEALTH BUREAU OF PLANT BREEDING AND GENETICS, Cambridge, for work that includes the abstracting and reviewing of biological literature—The Director, Commonwealth Bureau of Plant Breeding and Genetics, School of Agriculture, Cambridge (May 31).

SENIOR LECTURER or LECTURER IN ZOOLOGY at the University of Queensland, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, May 31).

DEMONSTRATORS IN EACH OF THE DEPARTMENTS OF INORGANIC AND STRUCTURAL, ORGANIC, and PHYSICAL CHEMISTRY—The Registrar, The University, Leeds 2 (June 1).

ASSISTANT PROFESSOR (preferably with an advanced degree, and research and/or adequate industrial experience in the fields of elasticity, mechanics and dynamics of machines); LECTURERS (with a good degree and experience in research or industry); and SESSIONAL LECTURERS (with a good degree) IN THE DEPARTMENT OF MECHANICAL ENGINEERING—Prof. D. L. Mordell, Chairman, Department of Mechanical Engineering, McGill University, Montreal, Canada.

LABORATORY TECHNICIAN IN THE DEPARTMENT OF MATERIA MEDICA AND PHARMACOLOGY—The Secretary, The Welsh National School of Medicine, 34 Newport Road, Cardiff.

LABORATORY TECHNICIAN (PHYSIOLOGIST) (aged 24–40, with A.I.M.L.T. preferably in bacteriology, or equivalent, and a good practical knowledge of physiological laboratory technology) with the East African Veterinary Research Organization—The Crown Agents, 4 Millbank, London, S.W.1, quoting M.3/43369/NF.

LABORATORY TECHNICIAN (preferably with some constructional experience of scientific apparatus) to assist in the preparation of apparatus for use in the properties of matter and optics teaching laboratories—The Registrar, The University, Liverpool 3, quoting Ref. No. 220.

OPERATING TECHNICIANS (with a sound general knowledge of electrical, electronic and vacuum equipment), for the main experimental thermonuclear power equipment—The Establishment Officer, Atomic Energy Research Establishment, Harwell, Didcot, Berks, quoting 750/34.

PHYSICIST or ELECTRICAL/MECHANICAL ENGINEER (with a first- or second-class honours degree or equivalent in physics or electrical or mechanical engineering) at the Royal Aircraft Establishment, Farnborough, Hants, to carry out research on electro-mechanical instruments used for flight testing aircraft and missiles—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.91/7A.

PHYSICIST or ENGINEER to work on physical problems associated with the development of automation in the textile industry—Dr. D. W. Hill, Director of Research, British Cotton Industry Research Association, Shirley Institute, Manchester 20.

POSTDOCTORAL and PREDOCTORAL RESEARCH ASSOCIATESHIPS IN EXPERIMENTAL AND THEORETICAL PHYSICS tenable in the Molecular Excitation Group—Dr. R. W. Nicholls, Department of Physics, University of Western Ontario, London, Ontario, Canada.

RESEARCH SCHOLARS (graduates or candidates with equivalent qualifications) IN THE DEPARTMENTS OF CHEMISTRY, COLOUR CHEMISTRY AND DYEING, TEXTILES AND/OR OTHER DEPARTMENTS—The Principal, Technical College, Queen Street South, Huddersfield.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Discovery Reports. Vol. 29, Pp. 1–128+plates 1–7: Hydromedusae from the Discovery Collections. By P. L. Kramp. (Cambridge: At the University Press, 1957.) 63s. net. [42

British Library of Political and Economic Science. Annual Report, 1955–56. Pp. 16. (London: British Library of Political and Economic Science, 1956.) [42

Proceedings of the University of Durham Philosophical Society. Vol. 12, No. 14: Botanizing in the Outer Hebrides in 1955 and 1956. By Prof. J. W. Heslop-Harrison. Pp. 141–150. Vol. 12, No. 15: The Age and Origin of the Hemiptera, with special reference to the Sub-Order Homoptera. By G. Heslop-Harrison. Pp. 150+169. (Durham: University of Durham Philosophical Society, 1956.) [42

Atomic Energy Research Establishment: Isotope Division. Radioactive Materials and Stable Isotopes, Catalogue No. 4. Pp. 221. (Harwell: Atomic Energy Research Establishment, 1957.) [42

Imperial College of Science and Technology (University of London). The Forty-ninth Annual Report of the Governing Body of the Imperial College of Science and Technology, 1955–1956. Pp. 101. (London: Imperial College of Science and Technology, 1956.) [42

Aero Research Technical Notes. Bulletin No. 168 (December, 1956): The Extent of Contact between Glue and Adherend. By N. A. de Bruyne. Pp. 12. (Duxford: Aero Research Limited, 1956.) [42

British Museum (Natural History). Expedition to South-West Arabia 1937–8. Vol. 1, Nos. 27–33. No. 27: Hemiptera: Tingidae. By Carl J. Drake. No. 28: Isoptera. By W. Victor Harris. No. 29: Coleoptera: Anthicidae. By Maurice Pic. No. 30: Coleoptera: Scraptiidae and Mordellidae. By Mario E. Franciscolo. No. 31: Hymenoptera: Vespidae. By A. Giordani Soika. No. 32: Revised List of Mr. Philby's Collecting Stations, with corrections and additions. By Hugh Scott. No. 33: Coleoptera: Paussidae. By A. Reichensperger. Pp. 415–492. (London: British Museum (Natural History), 1957.) 20s. [42

British Hat and Allied Feltmakers Research Association. Ninth Annual Report of the Director of Research for the year ended August, 1956. Pp. 23. (Manchester: British Hat and Allied Feltmakers Research Association, 1957.) [82

Chemical Service in Defence of the Realm: One Hundred Years of Chemical Inspection—The Story of the Chemical Inspectorate. By W. G. Norris. Pp. 91+12 plates. (Kidbrooke, London: Ministry of Supply, Chemical Inspectorate, 1957.) [122

University of Leeds. Annual Report of the Librarian, Session 1955–56. Pp. 11. (Leeds: The University Library, 1956.) [122

Macalloy Post-Tensioning Manual: a Handbook for the Engineer engaged in the design or construction of post-tensioned concrete, using Macalloy High Tensile Steel Bars. Pp. 80. (Sheffield: McCalls Macalloy, Ltd., 1957.) [122

British Museum (Natural History). The John Murray Expedition, 1933–34. Scientific Reports. Vol. 10, No. 3: Cephalochordata. By Dr. R. E. Webb. Pp. 121–128. (London: British Museum (Natural History), 1956.) 6s. [122

Other Countries

Kodaikanal Observatory. Bulletin No. 141, Part 1: Summary of Prominence Observations for the Second Half of 1953. Pp. 373–416 (Delhi: Manager of Publications, 1956.) Rs. 4/8/–. [291

The Journal of Solar Energy Science and Engineering. Vol. 1, No. 1, (January 1957). Pp. 64. Subscription rate: 10 dollars per year. (Phoenix, Arizona: Association for Applied Solar Energy, 1957.) [291

Institut Royal Météorologique de Belgique. Contributions. No. 22: Éléments de Météorologie. Chapitre 9: Météorologie Synoptique et Prévisions Météorologiques. Par P. Defrise. Pp. 39. (Bruxelles: Institut Royal Météorologique de Belgique, 1956.) [291

Union of South Africa: Division of Fisheries. Investigational Report No. 23: The South African Pilchard (*Sardinops ocellata*) and Maasbanker (*Trachurus trachurus*), Bird Predators, 1954–55. By Dr. D. H. Davies. Pp. 40. (Pretoria: Government Printer, 1956.) [291

Commonwealth Scientific and Industrial Research Organization, Australia. Proceedings of the International Wool Textile Research Conference, Australia, 1955. Vol. F: Histology of Wool and Hair and of the Wool Follicle. Pp. 228+51 plates. (Melbourne: Commonwealth Scientific and Industrial Research Organization, 1956.) [291

Publications de l'Institut National pour l'Étude Agronomique du Congo Belge. Carte des Sols et de la Végétation du Congo Belge et du Ruanda-Urundi. 6: Yangambi. Planchette 2: Yangambi A et B. Notice explicative de la Carte des Sols et de la Végétation. Par Gilson A. Van Wambeke et R. Gutzwillet. Pp. 36+2 cartes. 150 francs. 8: Vallée de la Lufira (Haut-Katanga). A: Sols. C.: Utilisation des Sols. Notice explicative de la Carte des Sols. Par A. Van Wambeke et M. F. Van Oosten. Pp. 71+2 cartes. 100 francs. (Bruxelles: Institut National pour l'Étude Agronomique du Congo Belge, 1956.) [42

Centro Brasileiro de Pesquisas Físicas. Notas de Físicas. Vol. 2, No. 10: East-West Asymmetry of Positive and Negative Mesons at the Geomagnetic Equator. By I. Escobar V. and F. B. Harris. Pp. 52. Vol. 2, No. 12: The First Excited States of the C^{13}–N^{13} Mirror Pair. By J. P. Davidson and J. J. Giambiagio. Pp. 12. Vol. 3, No. 3: Ohm's Law and Definition of Metallic State. By Guido Beck. Pp. 8. Vol. 3, No. 4: Diagrams for Processes Involving Hyperons. By J. Tiomno. Pp. 8. Vol. 3, No. 5: Directional Intensities of Positive and Negative Mesons in the Atmosphere. By I. Escobar V. and F. B. Harris. Pp. 9. Vol. 3, No. 6: Mean Free Path of 4.3 Bev Negative Pions in Nuclear Emulsions. By Alfredo Marques, Neusa Margem and G. A. B. Garnier. Pp. 7. (Rio de Janeiro: Centro Brasileiro de Pesquisas Físicas, 1955 and 1956.) [42

Yale Medical Library. Annual Report including the Report of the Historical Library, 1955–1956. Pp. 35. (New Haven, Conn.: Yale Medical Library, 1956.) [42

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Kungl. Sjöfartstyrelsen, Stockholm. Ergebnisse der Beobachtungen des Magnetischen Observatoriums zu Lovö (Stockholm) im Jahre 1954. Von Folke Eleman und Kjell Borg. Pp. 30. (Stockholm: Kungl. Sjöfartstyrelsen, 1956.) [42

Smithsonian Contributions to Astrophysics. Vol. 1, No. 1: New Horizons in Astronomy. Edited by Fred L. Whipple. Pp. x+181+plate 1. (Washington, D.C.: Government Printing Office, 1956.) 1.50 dollars. [42

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